CHAPTER 77

ENGINE INDICATING

TABLE OF CONTENTS

This Table of Contents lists subjects contained in Qantas 707-138 Maintenance Manual. Where these subjects conflict with those contained in Boeing 707 Stratoliner Maintenance Manual (Document D6-4004), the Company Manual will take precedence. Holders of Manuals when in receipt of Qantas Maintenance Manual revisions must revise the Table of Contents contained in the applicable chapter of both Manuals.

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CHAPTER 77

ENGINE INDICATING

TABLE OF CONTENTS

CHAPTER 77

ENGINE INDICATING

ALPHABETICAL INDEX

[1] AA 707-123 and QANTAS 707-138
[2] AA 707-123B and QANTAS 707-138B
[3] AA 707-123B

[2] AA 707-123B and QANTAS 707-138B
[5] AA 707-123

[2] AA 707-123B and QANTAS 707-138B
[4] QANTAS 707-138

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - DESCRIPTION AND OPERATION

1. General

A. The engine exhaust gas temperature (EGT) indicating system measures and provides engine exhaust gas temperature readings on remote temperature indicators on the engine instrument panel.

B. The system incorporates thermocouple devices which generate a d-c electrical signal for the operation of the indicators. Special wiring circuits, composed of alloys with particular resistance and temperature characteristics are used. The thermocouples for each engine are arranged into a wiring harness and lead assembly.

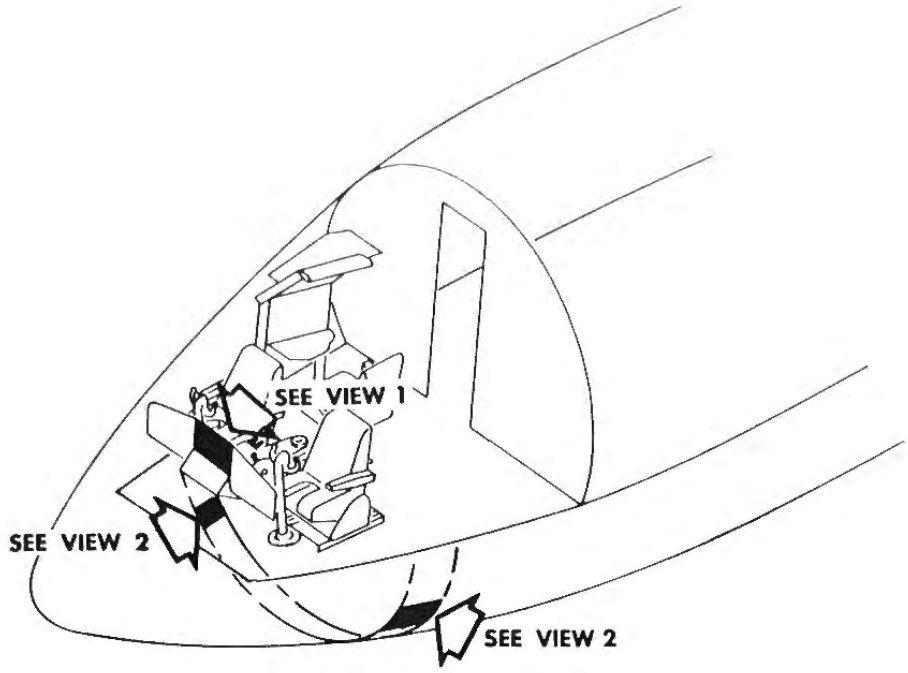
C. The engine exhaust gas temperature indicating system consists of sixteen thermocouple elements grouped in pairs and enclosed in eight probes arranged around each turbine rear housing, one variable thermocouple resistor for each engine and four temperature indicators on the engine instrument panel.

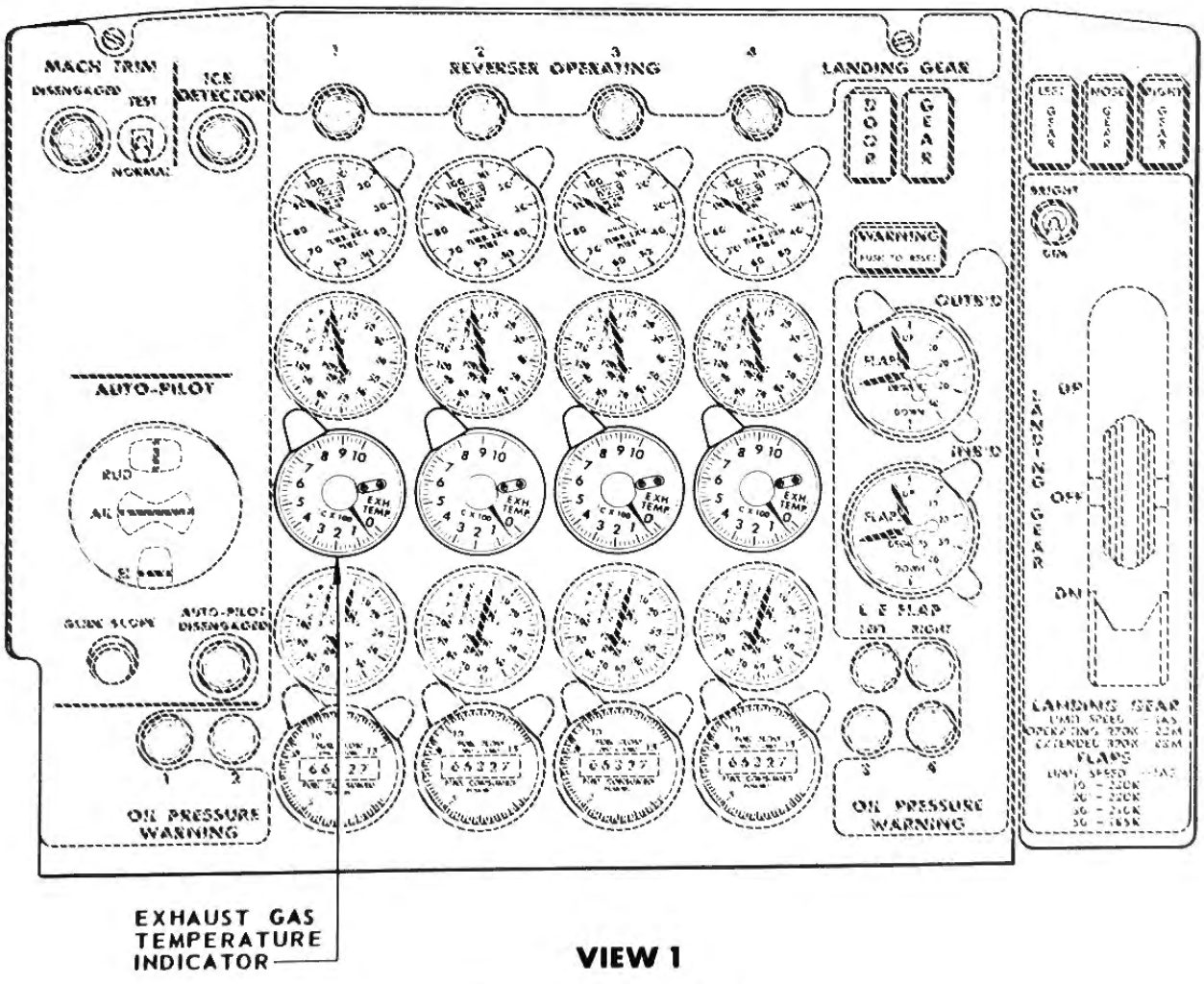
D. Engine exhaust temperature is sensed by the thermocouple elements. The heat of the exhaust gases causes the thermocouples to generate a d-c electrical signal which flows through an adjustable thermocouple resistor and actuates the meter movement of the exhaust temperature indicator. Copper and constantan wires are used in the low temperature zone of the engine and cromel and alumel wires are used where higher temperatures are encountered.

2. Exhaust Gas Temperature Thermocouples

A. The exhaust gas temperature thermocouple is a thermo-electrical device which produces a d-c electrical signal for operation of the system. (See figure 2.)

B. Two thermocouples are enclosed in each sampling probe mounted on the engine exhaust housing with the probes projecting into the exhaust stream. Each exhaust gas temperature thermocouple has a single junction. Eight thermocouples, one from each pair, are connected in parallel so that two wires carry the average of the exhaust gas temperature signals. The remaining one from each pair has separate wires in the thermocouple harness to allow selection of a signal from any one thermocouple. The thermocouple junction and studs are made of chromel and alumel material. The alumel stud terminal (-) is larger than the chromel stud terminal (+). The polarity of the thermocouples is also indicated by a green paint spot near the negative terminal. Each probe is provided with four gas inlet holes and one gas discharge hole.

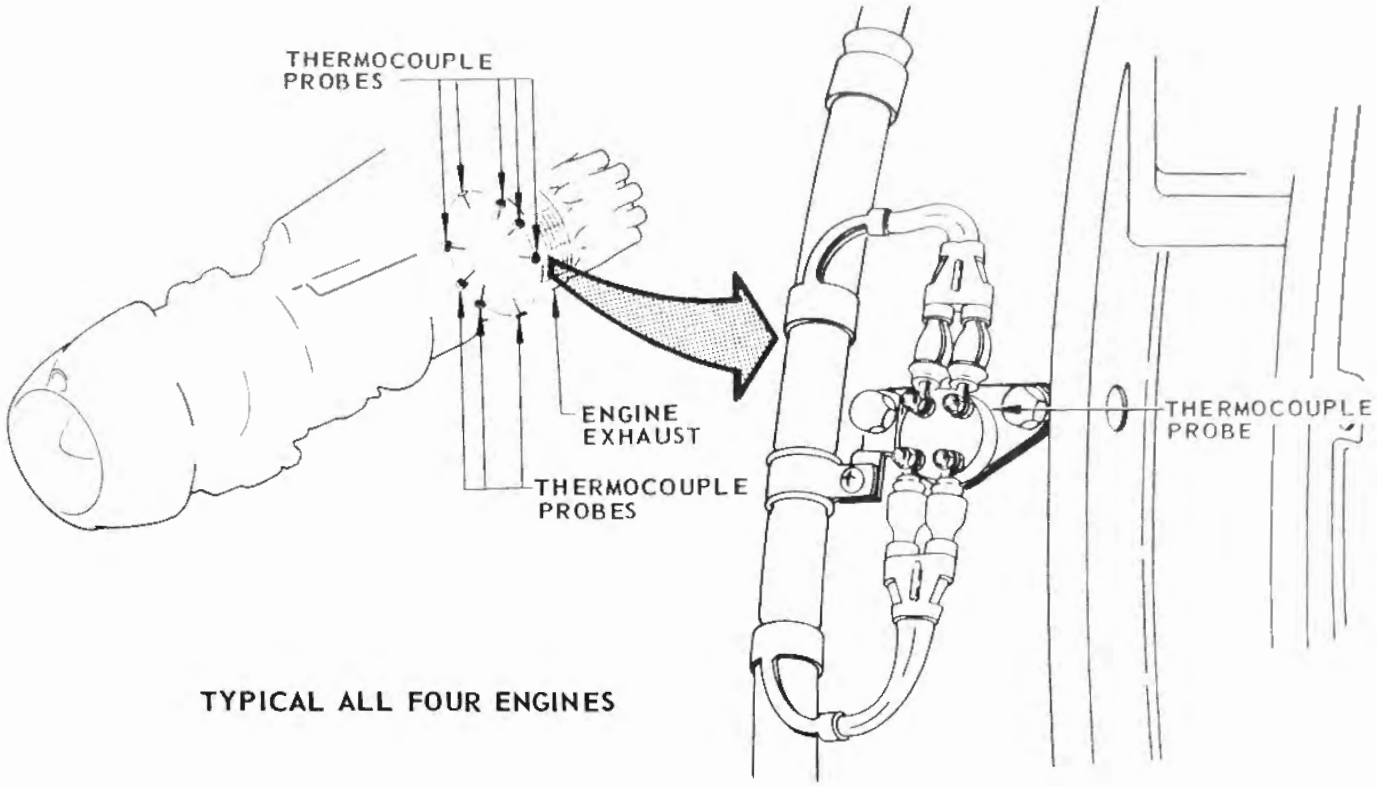


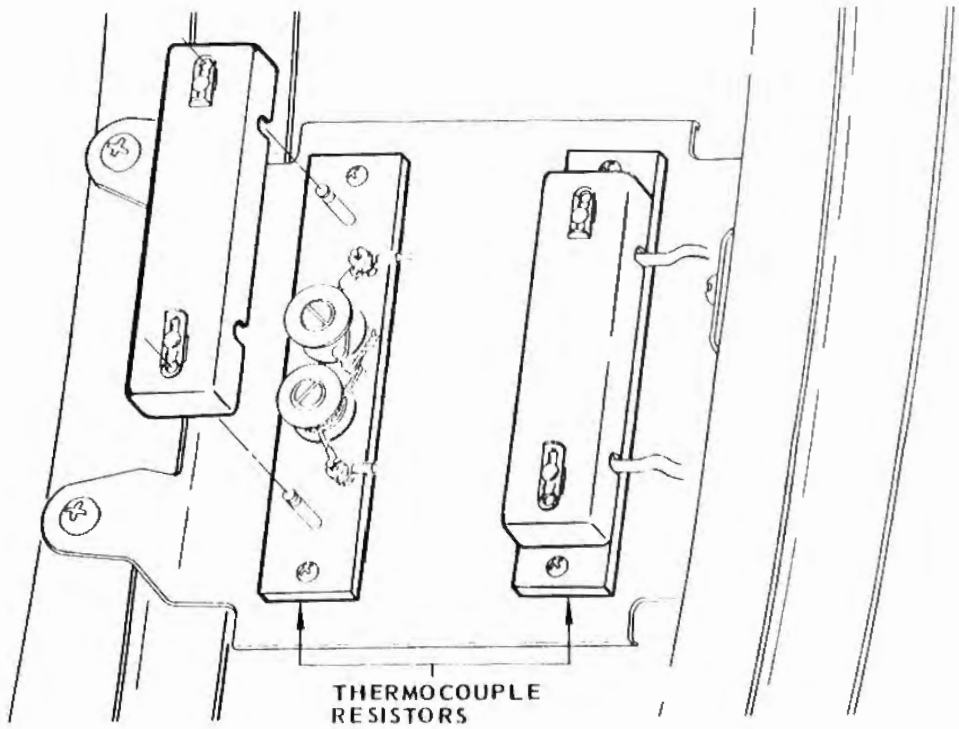


VIEW 1

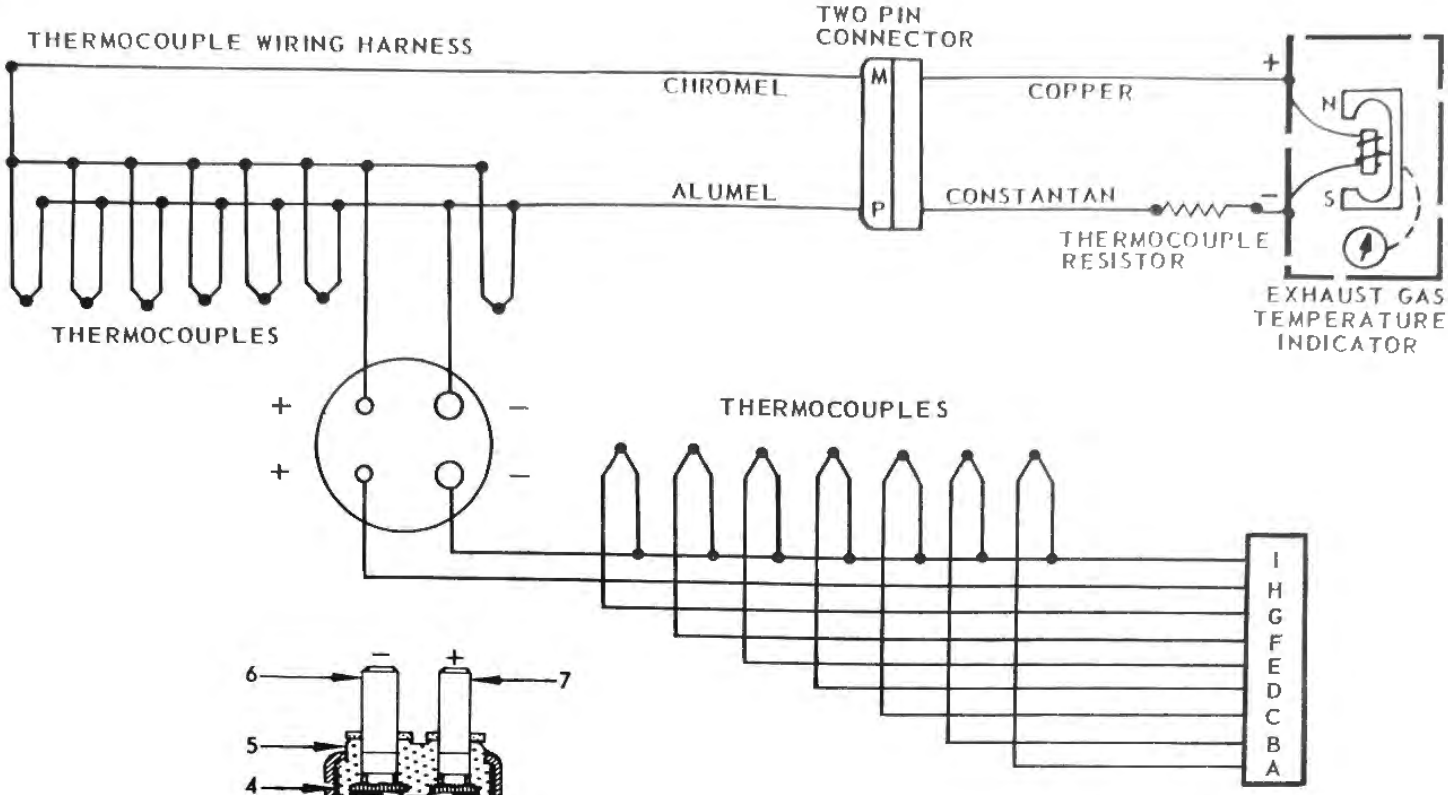
ENGINE INSTRUMENT PANEL

Exhaust Gas Temperature Indicating System Equipment Location
Figure 1 (Sheet 1 of 2)

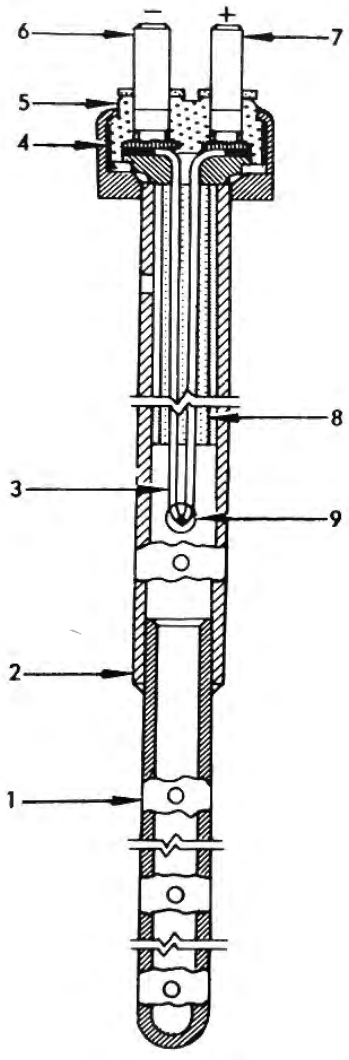

THERMOCOUPLE PROBES
ENGINE EXHAUST
THERMOCOUPLE PROBES
THERMOCOUPLE PROBE
TYPICAL ALL FOUR ENGINES


THERMOCOUPLE RESISTORS

VIEW 2



NINE PIN RECEPTACLE
A THROUGH H CROMEL
I ALUMEL



1 SHIELDING ASSEMBLY
2 TUBE-EXTENSION
3 CONDUCTOR
4 SHELL
5 BLOCK-TERMINAL
6 NEGATIVE STUD
7 POSITIVE STUD
8 INSULATION
9 JUNCTION

THERMOCOUPLE PROBE ASSEMBLY
(SHOWING ONE THERMOCOUPLE)

Exhaust Gas Temperature Indicating System Circuit
Figure 2

3. Exhaust Gas Temperature Thermocouple Resistor

A. The exhaust gas temperature thermocouple resistor adjusts circuit resistance values of the exhaust gas temperature indicating system. The elements of the resistor are two spools of No. 24 constantan wire with a resistance of 8.0 (+10% - 0%) ohms for each spool before adjustment. The thermocouple resistor is mounted on the circumferentials of the lower nose compartment, two on each side of the airplane about three feet above the compartment deck. (See figure 1.)

4. Exhaust Gas Temperature Indicator

A. The exhaust gas temperature indicator is a moving coil type instrument used in conjunction with temperature sensing thermocouple elements to register engine exhaust gas temperature readings. Four indicators, one for each engine are mounted on the engine instrument panel.

B. The exhaust gas temperature indicator is a sensitive voltmeter, hermetically sealed, with terminals in the back of the case marked to indicate "plus" for the chromel-stud terminal and "minus" for the alumel-stud terminal. The instrument dial indicates a temperature range from 0 to 1000°C, with normal and dangerous operating temperatures marked.

C. The indicators operate on the signals from the thermocouples. The two terminals on the back of the indicator connect the meter coils inside the unit to the thermocouple circuit. A screwdriver operated pointer adjustment on the back of the indicator allows approximately a 55° adjustment range at 700°C. The indicator is clamp mounted.

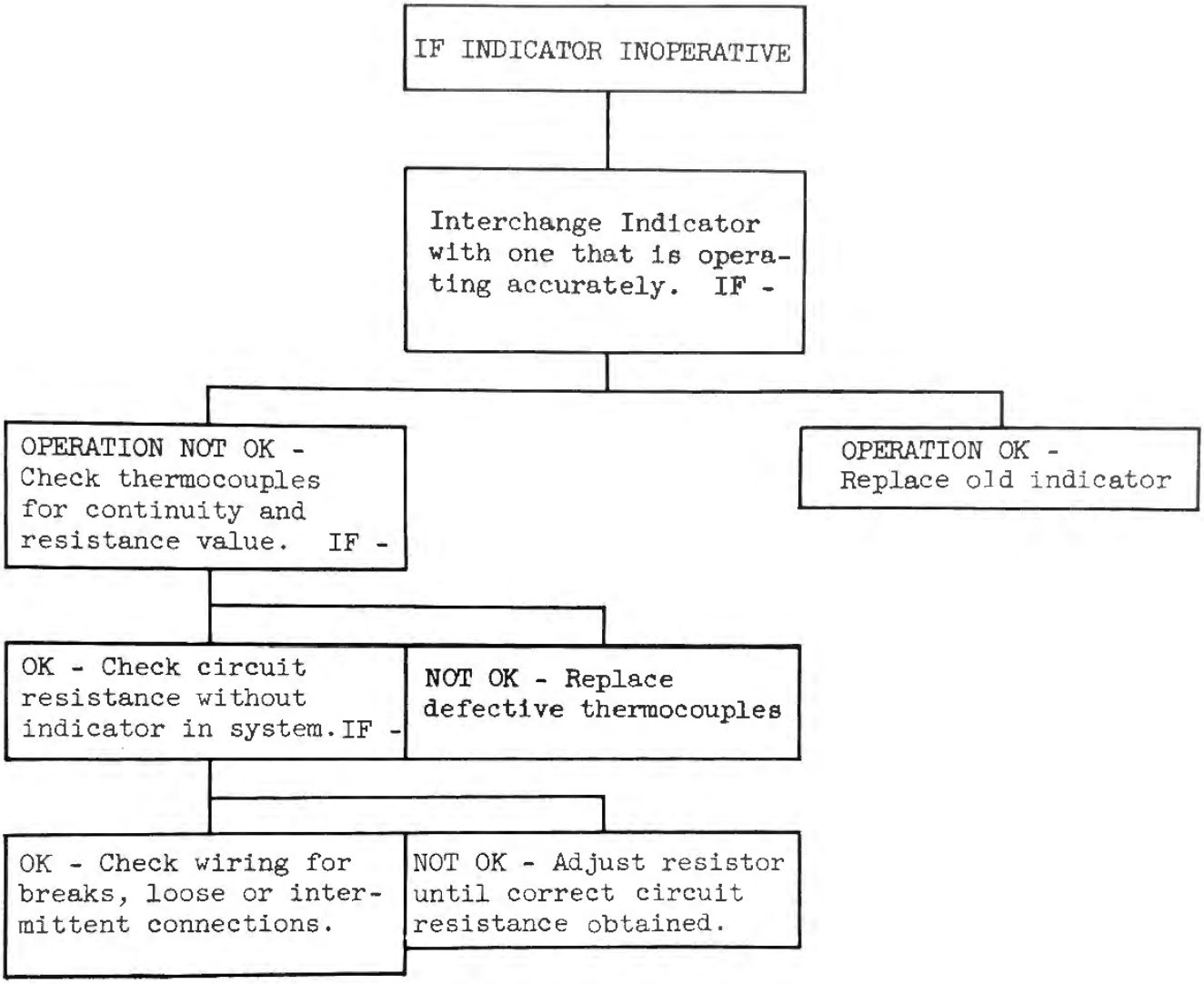
5. Exhaust Gas Temperature Thermocouple Harness

A. One part of the exhaust gas temperature thermocouple harness averages the electrical output from eight thermocouples by combining the signals in a parallel circuit which supplies the exhaust gas temperature indicator. The remaining wires in the harness take signals from the eight other thermocouples to a nine-pin receptacle near the front right side of the engine. This circuit is not continued in the existing installation.

B. The thermocouple harness consists of an electrical conduit mounted on the outer circumference of the exhaust housing. It is separated from the engine case by a heat shield. Attached to the harness is a thermocouple lead secured with clips and routed forward along the right side of the engine. The thermocouple lead is an electrical conduit with a plug at one end which connects to the thermocouple harness. The other end has two branches. One has a two-pin receptacle which continues the circuit to the exhaust gas temperature indicator, the other branch terminates at a nine-pin receptacle which is capped off on existing installation.

END

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - TROUBLE SHOOTING



END

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Exhaust Gas Temperature Indicating System

A. General

(1) The exhaust gas temperature (EGT) indicating system is most easily tested by measuring the resistance of the system. Tests include measurements of circuit resistance and insulation, thermocouple response and individual component resistance tests.

B. Special Tools and Equipment

(1) Wheatstone resistance bridge capable of measuring resistance to ± 0.1 ohm at 22 ohms.

(2) Ohmmeter capable of measuring resistance of 100,000 ohms.

D. Test Exhaust Gas Temperature Indicating System Resistance

(1) Disconnect leads from exhaust gas temperature indicator on engine instrument panel.

(2) Attach leads which have been disconnected from indicator to Wheatstone Bridge and measure circuit resistance of system. Resistance reading should be as shown in following table.

AMBIENT TEMPERATURE °C	SYSTEM RESISTANCE (OHMS)
20° ± 5°	22.00 (± 0.1)
10° ± 5°	21.95 (± 0.1)
0° ± 5°	21.90 (± 0.1)

NOTE: If resistance is not within tolerance, check circuit for loose, corroded or shorted connections and defective thermocouples.

(3) Adjust resistor spool to bring circuit resistance within specified tolerance.

E. Test Insulation Resistance

(1) To check for shorts to ground from indicator to disconnect plug of thermocouple lead.

(a) Disconnect two leads from exhaust gas temperature indicator on engine instrument panel.

(b) Connect together two leads removed from indicator with screw and nut.

(c) Disconnect thermocouple harness receptacle. Connect one side of ohmmeter to leads removed from indicator and other meter lead to ground.

(d) Check for short to ground from indicator to disconnect point of thermocouple lead. Resistance shall not be less than 100,000 ohms.

(e) Connect one side of ohmmeter to one thermocouple harness receptacle pin and other meter lead to ground to check for shorts of thermocouple harness. Resistance shall be no less than 1000 ohms. Repeat for all pins.

(f) Replace leads on exhaust gas temperature indicator and connect thermocouple lead to thermocouple harness receptacle.

END

(7) Turn change-over switch of Jetcal tester to EGT position and read exhaust temperature indicator on engine instrument panel, which should indicate temperature recorded in step (5) within ± 10°C.

NOTE: Test must be accomplished out of wind or erratic readings may result.

(8) Remove thermocouple tester cable from engine thermocouple connector and replace airplane connector in original position.

(9) Remove heater probes from engine thermocouples.

B. Test Exhaust Gas Temperature Indicating System Resistance

(1) Disconnect leads from exhaust gas temperature indicator on engine instrument panel.

(2) Attach leads which have been disconnected from indicator to Wheatstone Bridge and measure circuit resistance of system. Resistance reading should be 22 (±0.1) ohms.

NOTE: If resistance is not within tolerance, check circuit for loose, corroded or shorted connections and defective thermocouples.

(3) Adjust resistor spool to bring circuit resistance within specified tolerance.

C. Test Insulation Resistance

(1) To check for shorts to ground from indicator to disconnect plug of thermocouple lead.

(a) Disconnect two leads from exhaust gas temperature indicator on engine instrument panel.

(b) Connect two leads removed from indicator together with screw and nut.

(c) Disconnect thermocouple harness receptacle. Connect one side of ohmmeter to leads removed from indicator and other meter lead to ground.

(d) Check for short to ground from indicator to disconnect point of thermocouple lead. Resistance shall not be less than 100,000 ohms.

(e) Connect one side of ohmmeter to one thermocouple harness receptacle pin and other meter lead to ground to check for shorts of thermocouple harness. Resistance shall be no less than 1000 ohms. Repeat for all pins.

(f) Replace leads on exhaust gas temperature indicator and connect thermocouple lead to thermocouple harness receptacle.

EXHAUST GAS TEMPERATURE THERMOCOUPLE RESISTOR - MAINTENANCE PRACTICES

1. Adjustment/Test Exhaust Gas Temperature Thermocouple Resistor

A. General

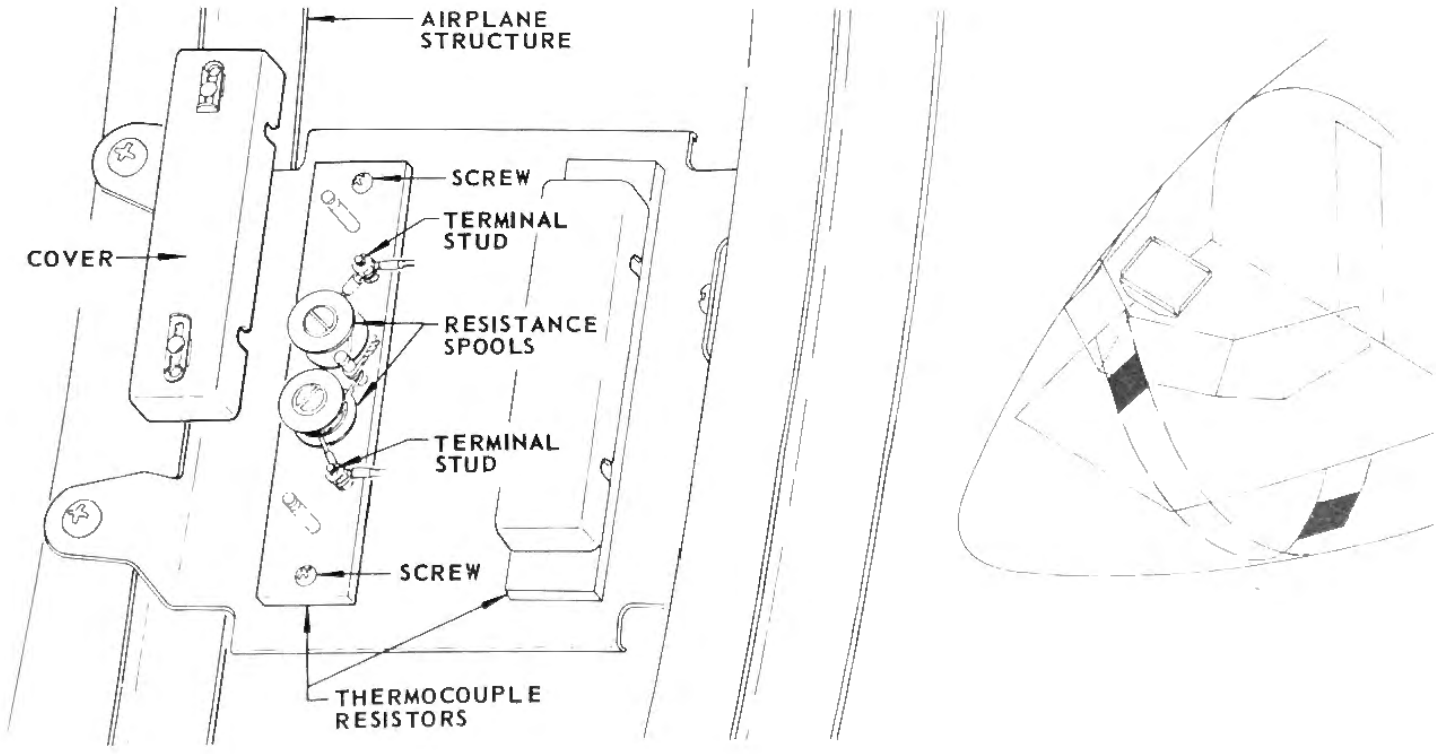
(1) The exhaust gas temperature thermocouple resistor is adjusted by shortening the resistance wire on the spools. Circuit resistance, excluding indicator. must be 22.00 (± 0.1) ohms. Total resistance of circuit including indicator is approximately 55 ohms. If it is necessary to increase circuit resistance, a new resistor must be installed and correctly adjusted. (See figure 201.)

B. Adjust Exhaust Gas Temperature Thermocouple Resistor

(1) Remove exhaust gas temperature indicator from instrument panel.

(2) Remove wiring from indicator. Make good electrical connection between the two conductors on airplane wiring side of disconnect by bolting terminals together.

(3) Obtain access to thermocouple resistor through cabin insulation. Remove cover from resistor box. (See figure 201.)



Exhaust Gas Temperature Thermocouple Resistor Installation
Figure 201

(5) Adjust resistor by unwinding resistor wire and measuring circuit resistance as turns of wire are removed. Wire resistance is approximately 0.73 ohm per foot.

(6) When correct circuit resistance of 22.00 (±0.10) ohms is obtained, silver-solder resistance wire ends together.

(7) Wind excess wire around post between resistor spools.

(8) Replace resistor cover.

(9) Replace cabin insulation.

(10) Install exhaust gas temperature indicator on engine instrument panel.

END

EXHAUST GAS TEMPERATURE THERMOCOUPLES - MAINTENANCE PRACTICE

1. Removal/Installation Exhaust Gas Temperature Thermocouple

A. Remove Exhaust Gas Temperature Thermocouple (See figure 201.)

(1) Obtain access to thermocouples by opening side cowl panels.

(2) Remove fairings on strut above position of thermocouples, as noted in table. Refer to Chapter 12.

Engine number	Fairing number Right side	Left side
2 & 3	726	727
1 & 4	760	761

(3) Remove thermocouple harness leads from thermocouples.

(4) Remove eight segments of thrust reverser shroud.

(5) Remove two bolts which fasten thermocouple to exhaust chamber.

(6) Remove thermocouple from engine.

B. Install Exhaust Gas Temperature Thermocouple (See figure 201.)

(1) Place thermocouple on mounting pad so that four gas holes in sampling probe face upstream.

(2) Install and tighten two mounting bolts 40 to 50 pound-inches.

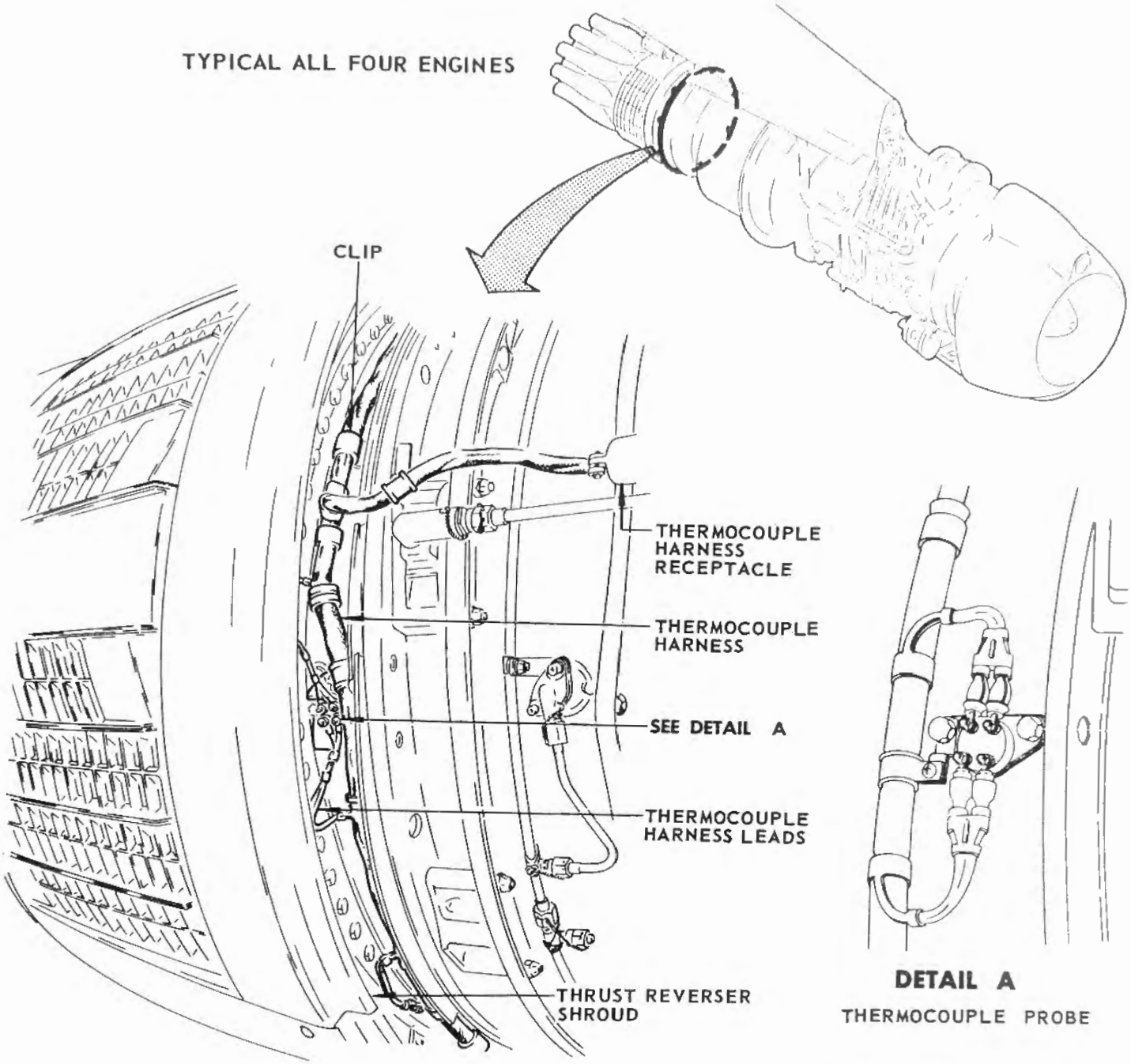
(3) Replace eight segments of thrust reverser shroud.

(4) Connect thermocouple harness leads to studs on thermocouples and tighten nuts to approximately 20 pound-inches.

(5) Position thermocouple harness and fasten thermocouple harness clips.

(6) Install fairings removed in paragraph 1.A.(2).

(7) Close side cowl panels.



Exhaust Gas Temperature Thermocouple Installation
Figure 201

2. Adjustment/Test Exhaust Gas Temperature Thermocouple

A. Test Exhaust Gas Temperature Thermocouple

(1) Place a soldering copper of at least 500 watts capacity against a thermocouple probe. Observe exhaust gas temperature indicator on engine instrument panel which should show a small reading. Allow time for indicator to return to zero then repeat procedure for each thermocouple probe.

NOTE: This is not a calibration check.

EXHAUST GAS TEMPERATURE THERMOCOUPLE HARNESS AND LEAD - MAINTENANCE PRACTICES

1. Removal/Installation Exhaust Gas Temperature Thermocouple Harness and Lead

A. Remove Exhaust Gas Temperature Thermocouple Harness and Lead (See figure 201.)

(1) Disconnect thermocouple lead from thermocouple harness receptacle.

(2) Remove four screws with nuts holding thermocouple harness receptacle to bracket on engine flange bolt circle.

(3) Disconnect thermocouple harness leads from respective thermocouples around periphery of engine exhaust housing. Tag thermocouple harness leads.

(4) Loosen harness supporting clips and remove harness.

(5) Disconnect support clips from thermocouple lead, unbolt two EGT lead receptacles near front of engine and coupling on fire seal.

(6) Remove thermocouple lead.

B. Install Exhaust Gas Temperature Thermocouple Harness and Lead (See figure 201.)

(1) Position thermocouple harness around engine exhaust housing and bolt thermocouple harness receptacle to bracket on engine flange bolt circle. Connect thermocouple harness leads.

(2) Insert thermocouple lead through fireseal and connect thermocouple lead plug to thermocouple harness receptacle.

(3) Route thermocouple lead under pressure tube at diffuser case, under right ignition compositor, and then forward to mount bracket below anti-icing valve.

(4) Bolt both thermocouple lead receptacles in place with nine pin receptacle in uppermost place.

2. Adjustment/Test Exhaust Gas Temperature Thermocouple Harness and Lead

A. Special Tools and Equipment

(1) Sensitive resistance measuring device

(2) 500-volt megohmmeter

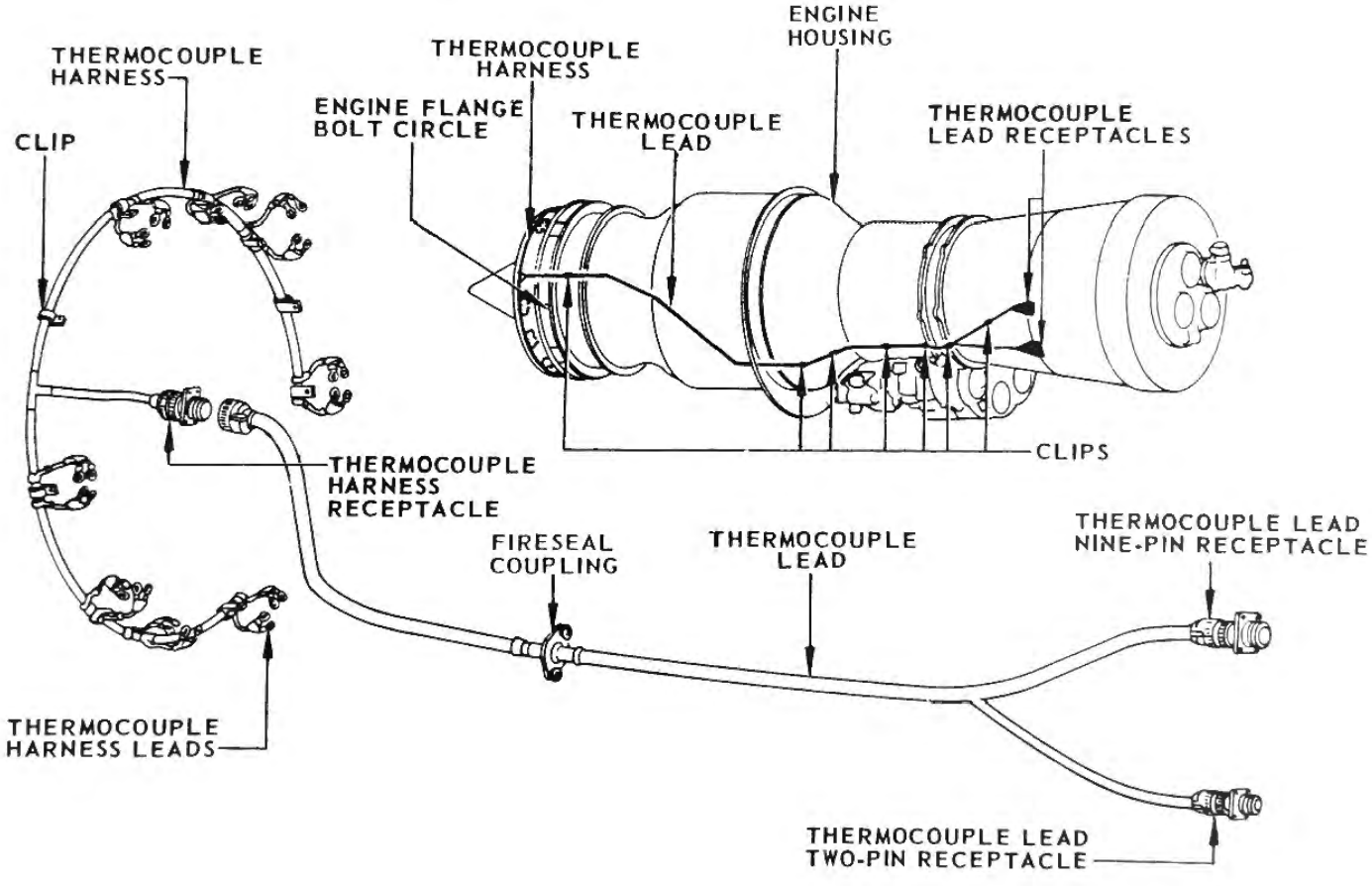
B. Test Exhaust Gas Temperature Thermocouple Harness Leads Continuity

(1) Disconnect the four thermocouple leads from any thermocouple.

(2) Connect ohmmeter across one pair of leads. Check for continuity. Repeat for other pair of leads.

NOTE: One pair of leads from each probe form part of an incomplete circuit and will give a "no continuity" result when tested. Remaining pair should show continuity when tested.

(3) Repeat steps (1) and (2) for all thermocouples.



Exhaust Gas Temperature Thermocouple Harness Installation
Figure 201

C. Test Exhaust Gas Temperature Thermocouple Harness and Thermocouple Resistance

(1) Disconnect thermocouple harness receptacle.

(2) Using resistance measuring instrument check resistance between pins. Maximum reading should not exceed 2.05 ohms at 68°F (20°C).

(3) If resistance is not within limits, disconnect harness from thermocouples and check that resistance of individual thermocouples does not exceed 0.25 ohms. If resistance of thermocouples is within limits then harness or leads are defective and should be replaced.

(4) While harness is disconnected check the insulation resistance between each terminal and the thermocouple probe body. If resistance is between 10,000 and 2500 ohms the probe should be noted for replacement at the earliest opportunity.

D. Test Exhaust Gas Temperature System Thermocouple Harness and Lead Insulation

(1) Disconnect thermocouple lead at two-pin receptacle.

(2) Place 500-volt megohmmeter test clip on one thermocouple lead connection pin and the other test clip on thermocouple lead outer wire braid. Flex harness and lead gently while observing instrument. A fluctuating resistance of less than 25,000 ohms may indicate moisture. Repeat for other pins.

CAUTION: REPEATED SEVERE FLEXING OR BENDING MAY BREAK OR FRAY THE INSULATION OF THE HARNESS OR LEAD. DO NOT ATTEMPT TO BEND HARNESS OR LEAD AROUND A SMALL RADIUS.

(3) If a low or fluctuating resistance is indicated remove harness and lead, disconnect harness from lead; measure and record insulation resistance of each assembly.

(4) Bake harness and lead at 200° to 250°F for one hour. Recheck insulation resistance values. A substantial increase in resistance indicates that moisture was the cause of original low readings.

(5) Install and connect the harness and lead: connect harness leads to thermocouples. Repeat step (2). Again measure the resistance which must show a steady reading of at least 25,000 ohms at 68°F (20°C).

END

ENGINE TACHOMETER SYSTEM - DESCRIPTION AND OPERATION

1. General

A. The engine tachometer system measures and indicates the rotary speed of the engine low pressure and high pressure compressor rotors.

B. The tachometer system provides dial rpm readings to the remote tachometer indicator by means of a generator connected to the engine. The tachometer generator supplies a three-phase electrical signal for the operation of the system.

C. The engine tachometer system incorporates two engine driven generator units (N_1, N_2) for each engine, with corresponding tachometer indicators on the engine instrument panel. Tachometer system N_1 indicates the speed of rotation of the low pressure compressor. Tachometer system N_2 registers the speed of rotation of the high pressure compressor. (See figure 1.)

2. Engine Tachometer Generator

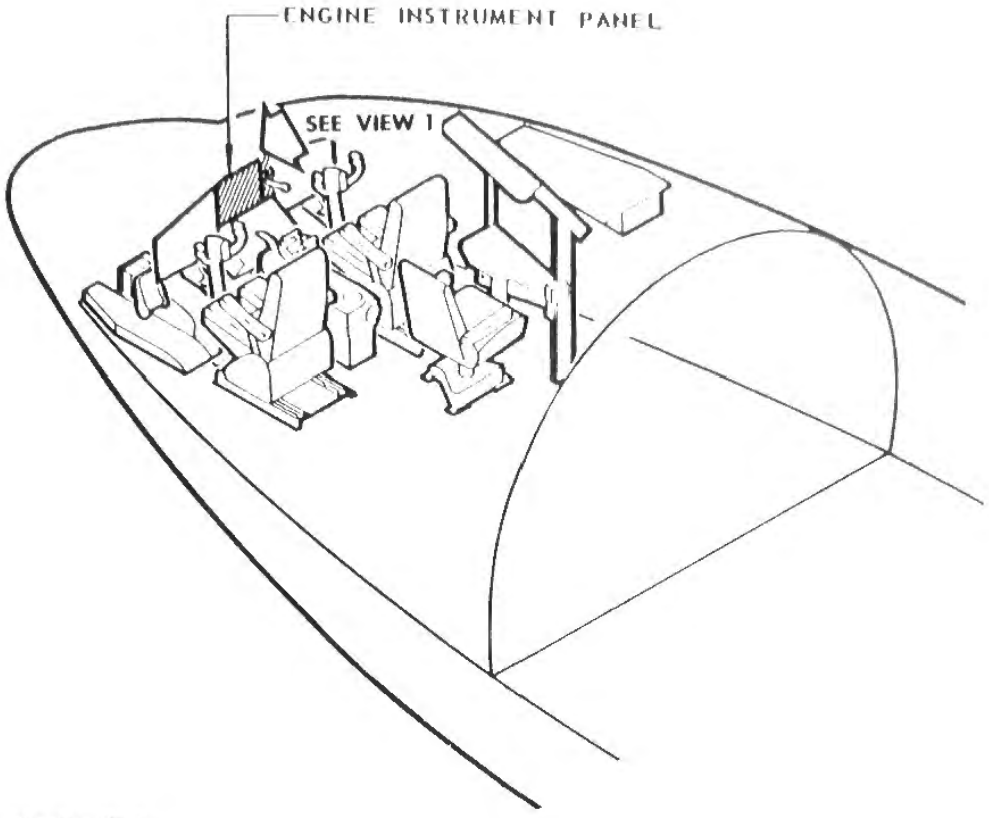
A. The engine tachometer generators (N_1 and N_2) are used in conjection with the corresponding tachometer indicators on the engine instrument panel, and supply the a-c power for the operation of the indicators. Each tachometer generator consists of a stator and a specially designed, permanently magnetized rotor. A generator drive shaft, driven by the engine, turns a rotor inside the stator coil and thus generates an electrical signal, the frequency of which is a function of the engine compressor rpm. The electrical signal is transmitted by the corresponding tachometer indicator on the engine instrument panel by a two-wire system; the third phase is completed by ground. (See figure 2.)

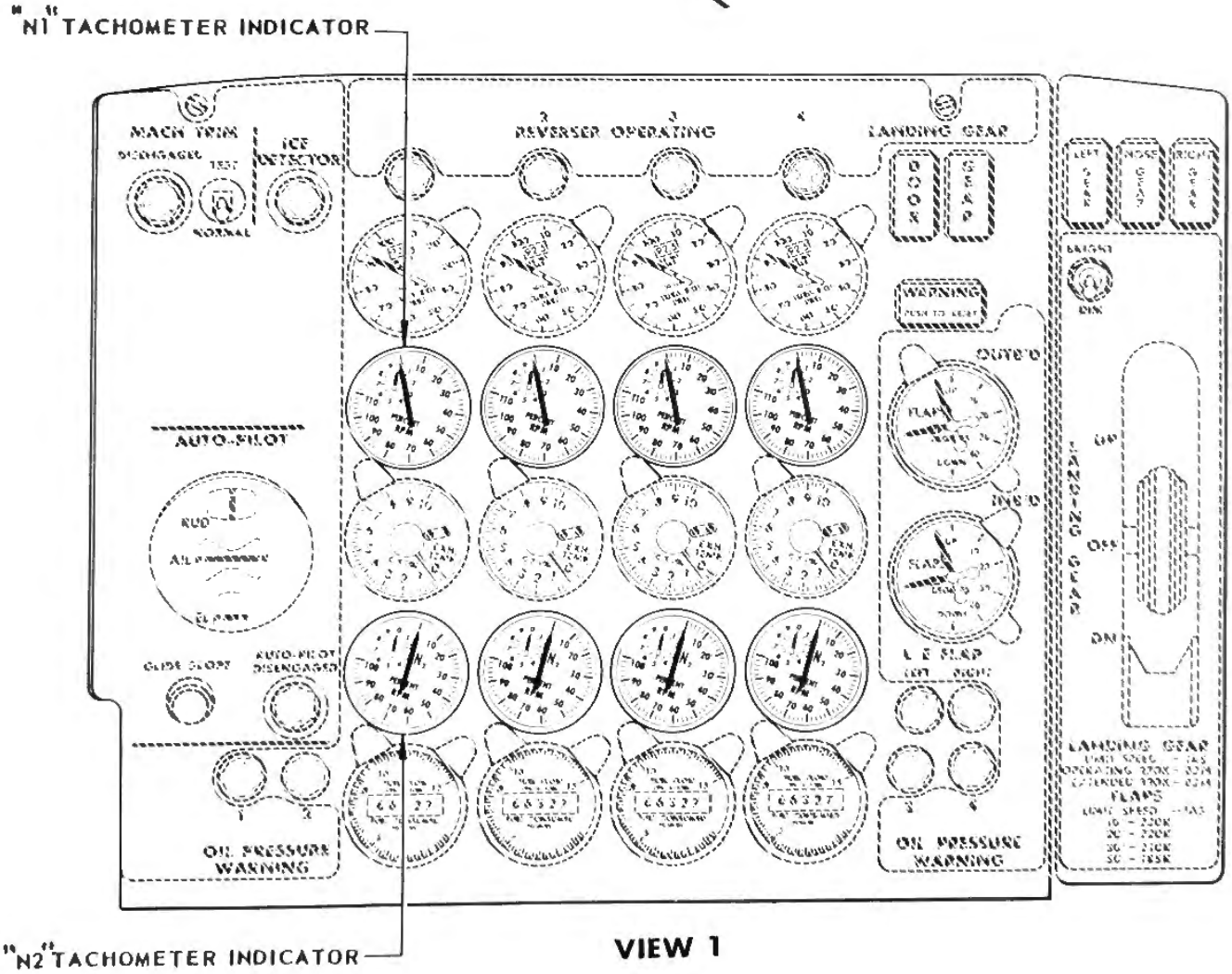
B. The N_1 tachometer generator is located on the front accessory drive and the N_2 tachometer generator is located on the main accessory drive housing between the starter pad and water injection pump. Each tachometer is driven by its respective compressor rotor through reduction gearing.

3. Engine Tachometer Indicator

A. The engine tachometer indicator registers engine rotor rpm on the remote engine instrument panel. (See figure 1.)

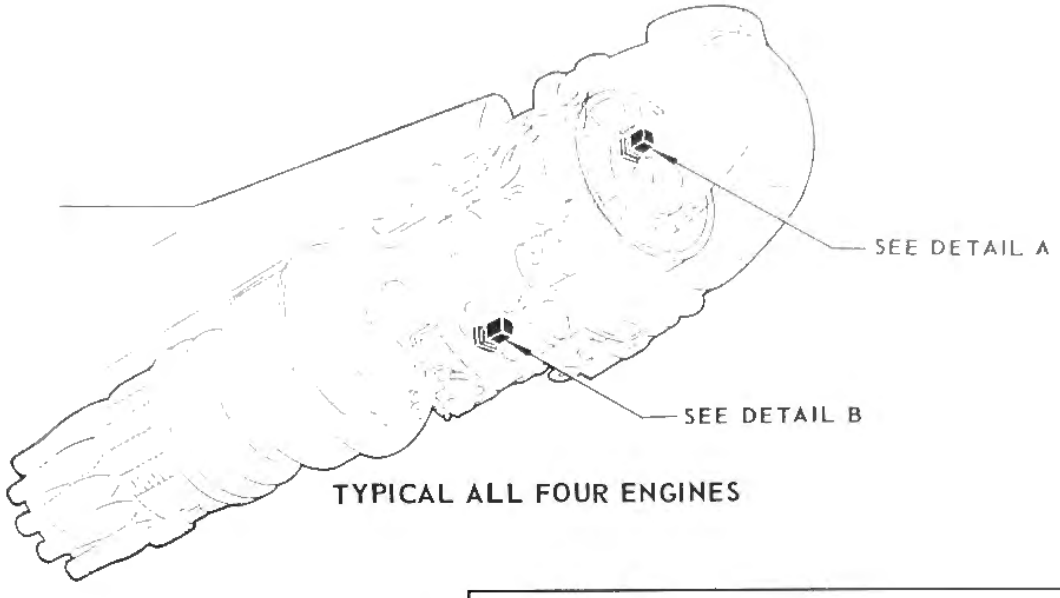
B. The tachometer indicator is hermetically sealed and clamp mounted on the engine instrument panel. It contains a three-phase synchro-motor driving a hairspring restrained, induction drag cup mechanism. The motor rotates at exactly the same speed as the tachometer generator shaft. The tachometer indicator receives its power and speed controlling frequency from the engine driven tachometer generator. The tachometer indicator dial allows readings between zero and 110% rpm.



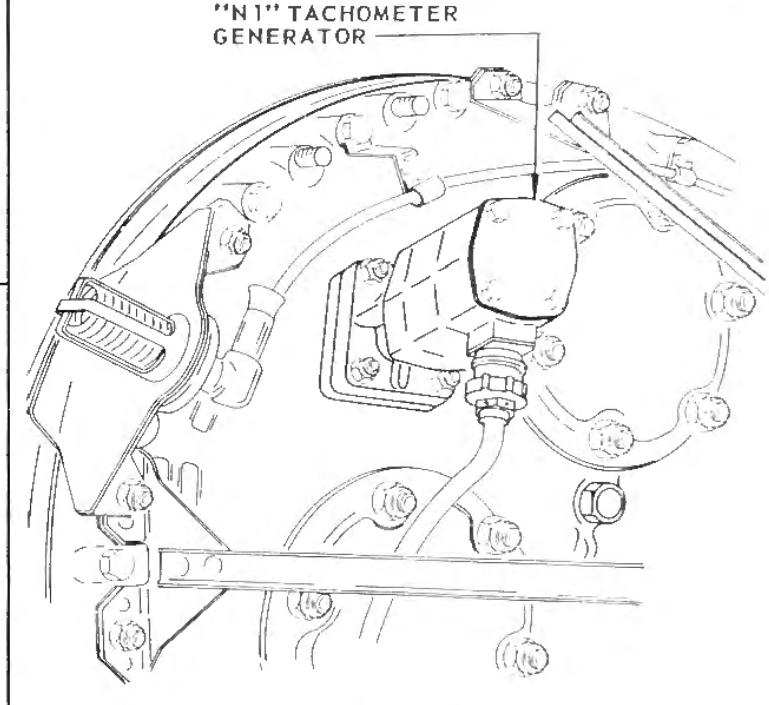


VIEW 1

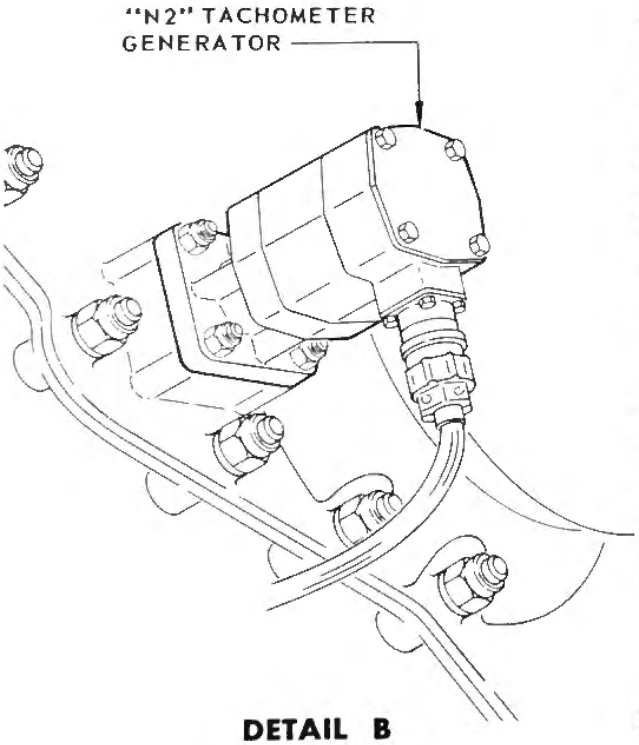
Engine Tachometer System Equipment Location
Figure 1 (Sheet 1 of 2)



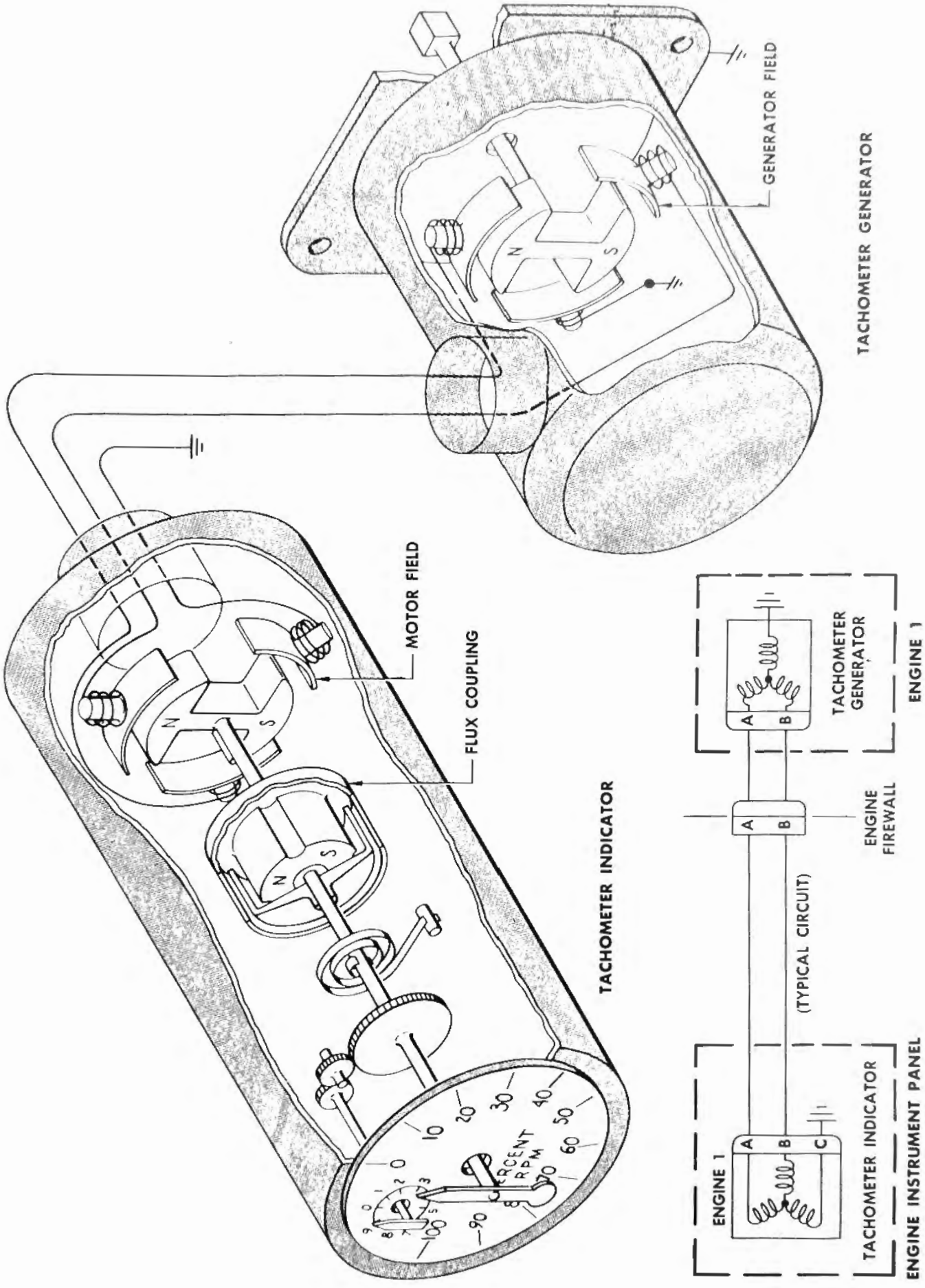
TYPICAL ALL FOUR ENGINES



DETAIL A

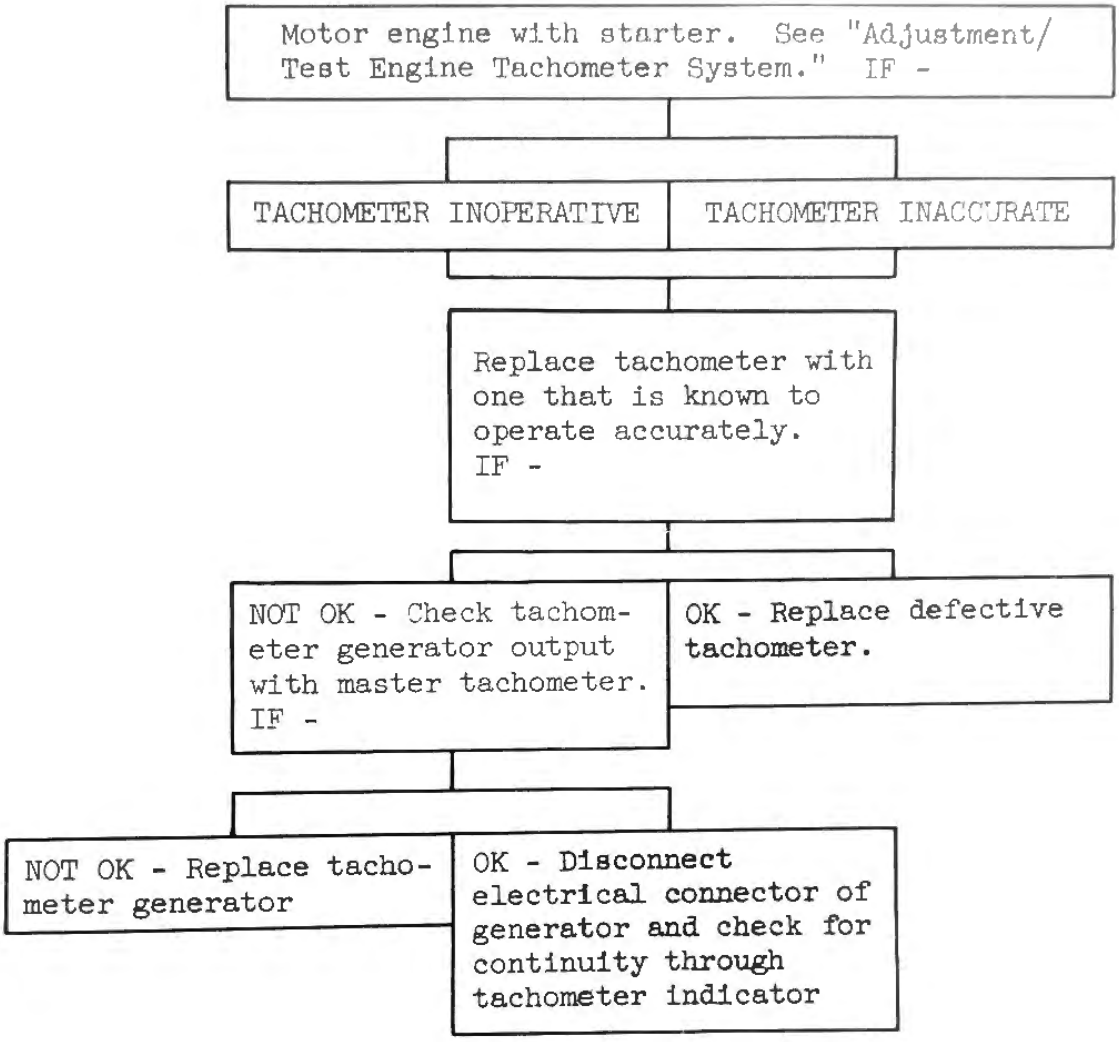


DETAIL B



Engine Tachometer Schematic
Figure 2

ENGINE TACHOMETER SYSTEM - TROUBLE SHOOTING



END

ENGINE TACHOMETER SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Engine Tachometer System

A. General

(1) The engine tachometer system can be tested only during engine run-up.

B. Equipment

(1) Master tachometer (with calibration correction chart).

(2) Adapter harness for master tachometer.

C. Test Engine Tachometer System

(1) Remove tachometer indicator from instrument panel.

(2) Using adapter harness, connect master tachometer into system in parallel with engine tachometer indicator.

NOTE: Compare reading of the engine tachometer indicator with that of the master instrument at all speeds. At speeds below 95% rpm both instruments must agree within 2% rpm. At engine rpm between 95 and 102% both instruments must agree within 1%.

END

ENGINE TACHOMETER GENERATOR - MAINTENANCE PRACTICES

1. Removal/Installation Engine Tachometer Generator

A. Equipment and Materials

(1) Grease - MIL-L-3545, or equivalent

B. Remove Engine Tachometer Generator (See figure 201.)

(1) Disconnect electrical connector from engine tachometer generator.

(2) Remove attaching nuts and washers which fasten tachometer generator to drive.

(3) Remove generator and discard old gasket.

C. Install Engine Tachometer Generator (See figure 201.)

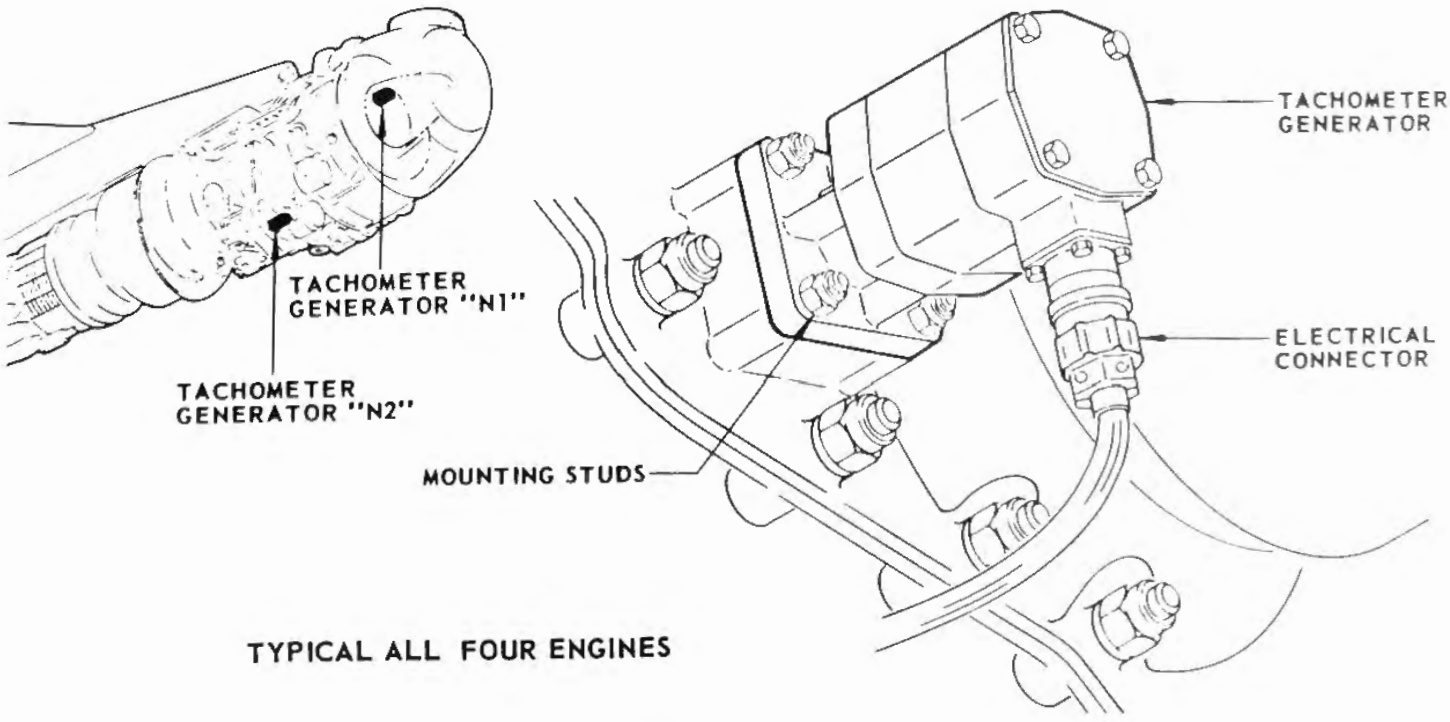
(1) Lightly coat splines of tachometer generator drive shaft with grease.

(2) Place new gasket on mounting pad.

(3) Place engine tachometer generator on mounting pad and carefully align drive shaft of tachometer generator.

(4) Install washers and nuts attaching generator to engine.

(5) Attach electrical connector to generator.



Engine Tachometer Generator Installation
Figure 201

TURBINE DISCHARGE PRESSURE INDICATING SYSTEM - DESCRIPTION AND OPERATION

1. General

A. The turbine discharge pressure indicating system provides turbine discharge pressure (Pt_7) readings on the engine instrument panel. This information is needed for adjusting engine thrust.

B. The turbine discharge pressure indicating system for each engine consists of six discharge pressure sensing probes around the periphery of the engine exhaust housing, a turbine discharge pressure transmitter, located on the forward part of the engine and an indicator on the engine instrument panel. (See figure 1.)

2. Turbine Discharge Pressure Sensing Probes

A. The six turbine discharge pressure probes are equally spaced around the casing of the turbine discharge chamber. Each probe is a plain straight tube with one end open and extending into the discharge gas stream. The other end connects with the turbine discharge pressure sensing manifold.

3. Turbine Discharge Pressure Sensing Manifold

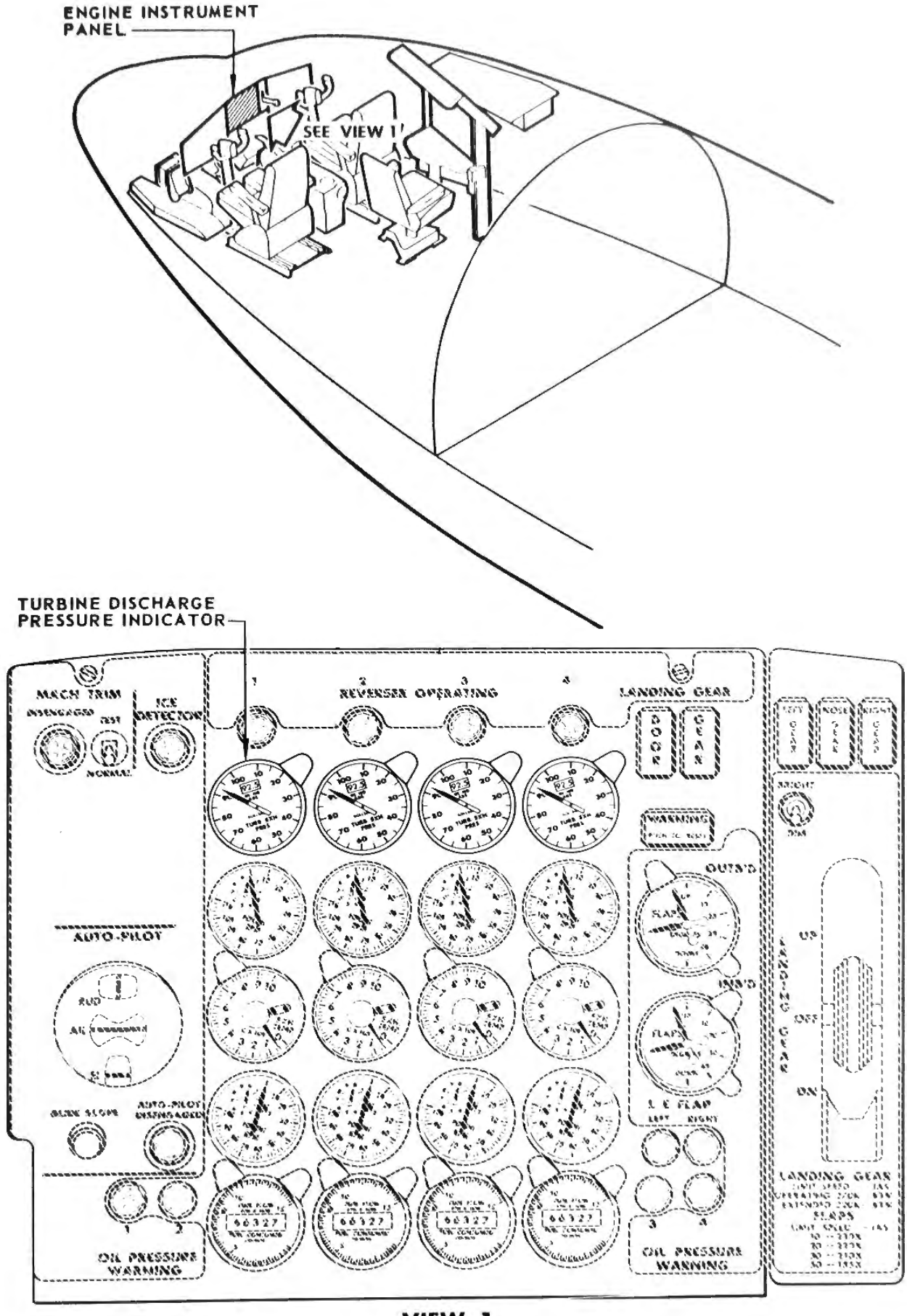
A. The turbine discharge pressure sensing manifold is a split tube mounted around the periphery of the turbine discharge housing. Six smaller tubes from the manifold connect with the probes extending into the discharge chamber. The manifold averages out the pressure values sensed by the probes.

4. Turbine Discharge Pressure Transmitter

A. The turbine discharge pressure transmitter converts turbine discharge pressure into an electrical signal which operates the turbine discharge pressure indicator. The transmitter consists of a metal bellows in a chamber, a linkage mechanism and a syncro transmitter. The turbine discharge pressure (Pt_7) acts on the metal bellows. The transmitter is located at the top of the engine on the front compressor case.

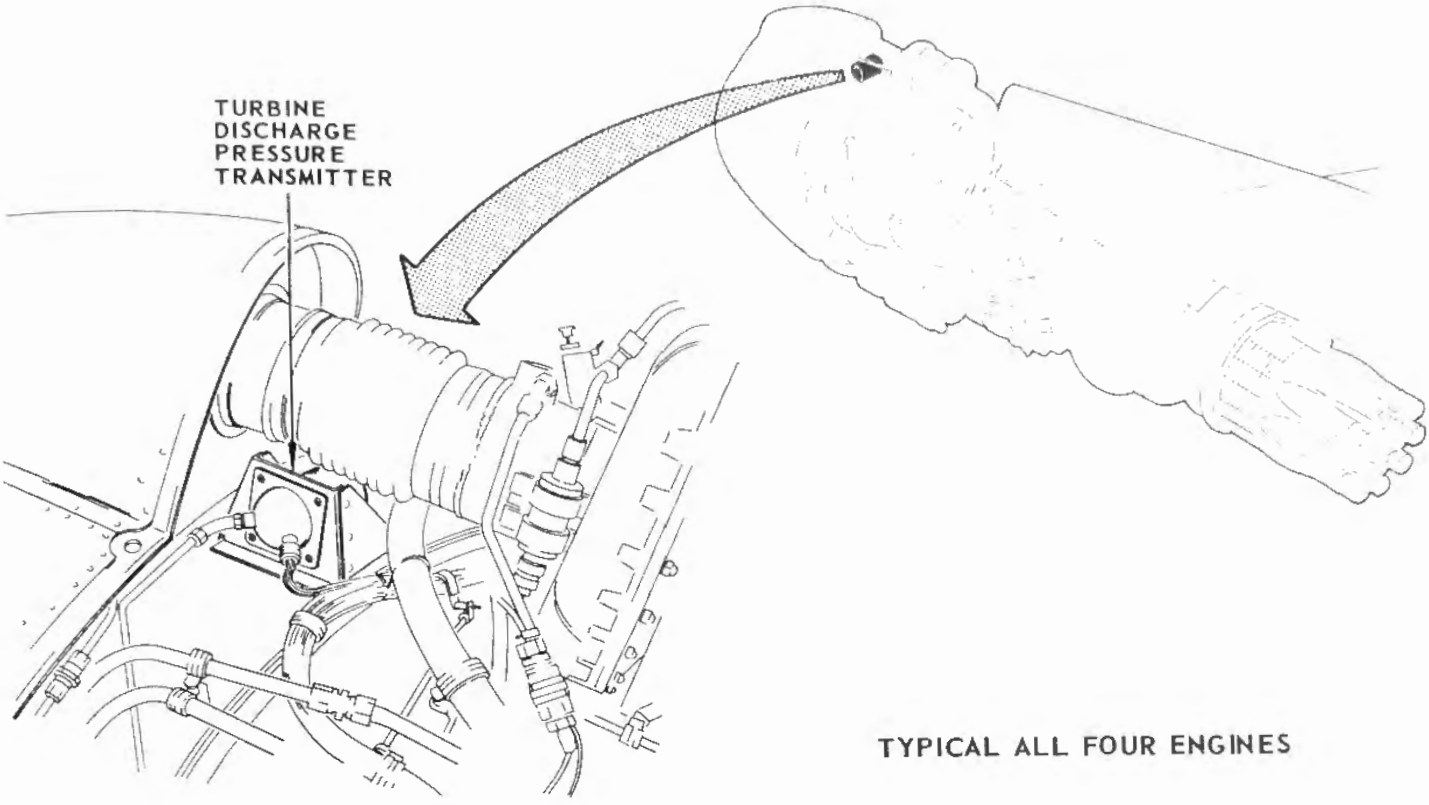
5. Turbine Discharge Pressure Indicator

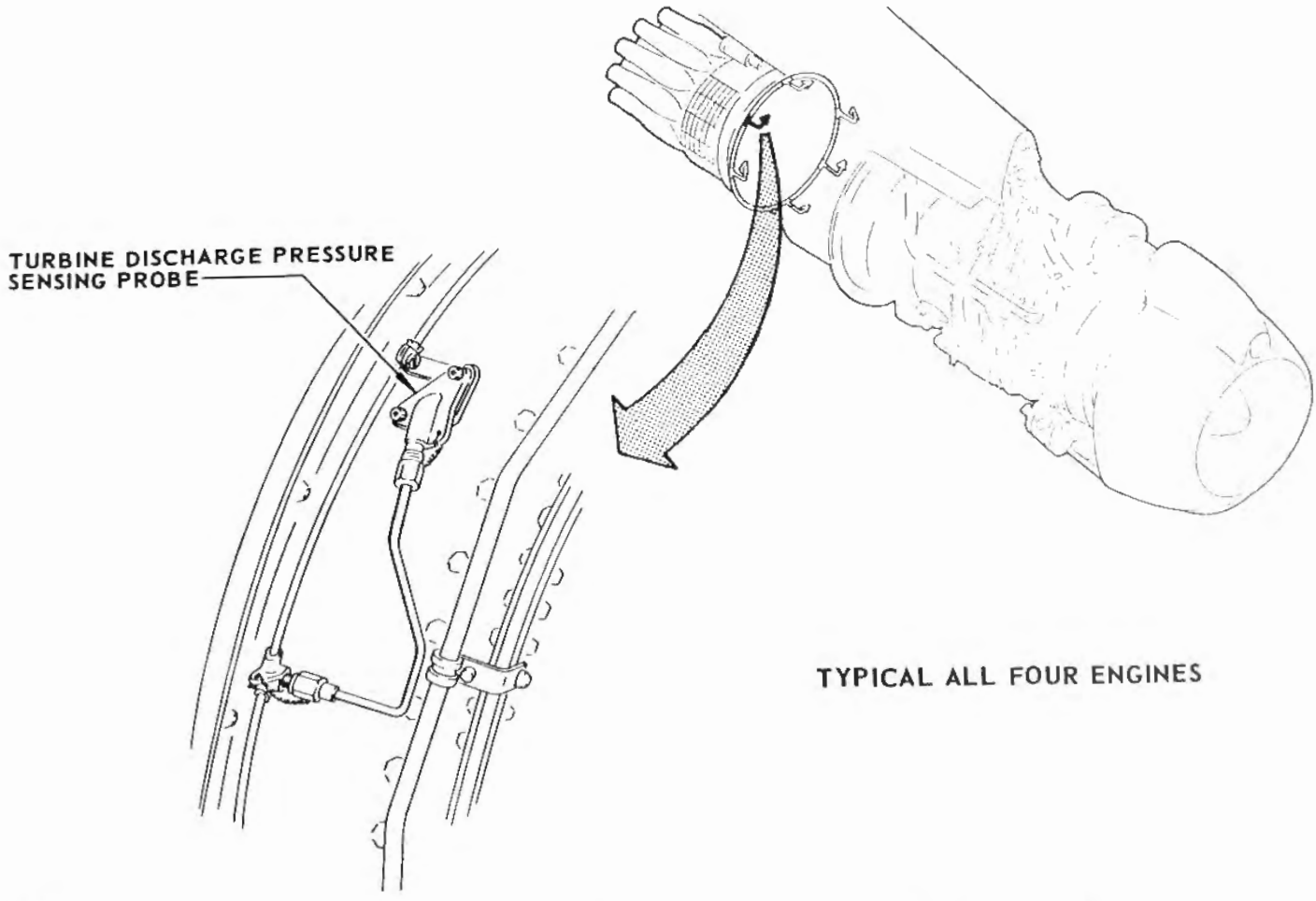
A. Four turbine discharge pressure indicators are located on the engine instrument panel. Each contains a syncro receiver which is actuated by the electrical signal received from its respective turbine discharge pressure transmitter. The indicator registers the pressure in the turbine discharge chamber (Pt_7). The dial calibration is from 10 to 100 inches of mercury, absolute pressure. (See figure 1.)



VIEW 1

Turbine Discharge Pressure Indicating System Equipment Location
Figure 1 (Sheet 1 of 2)

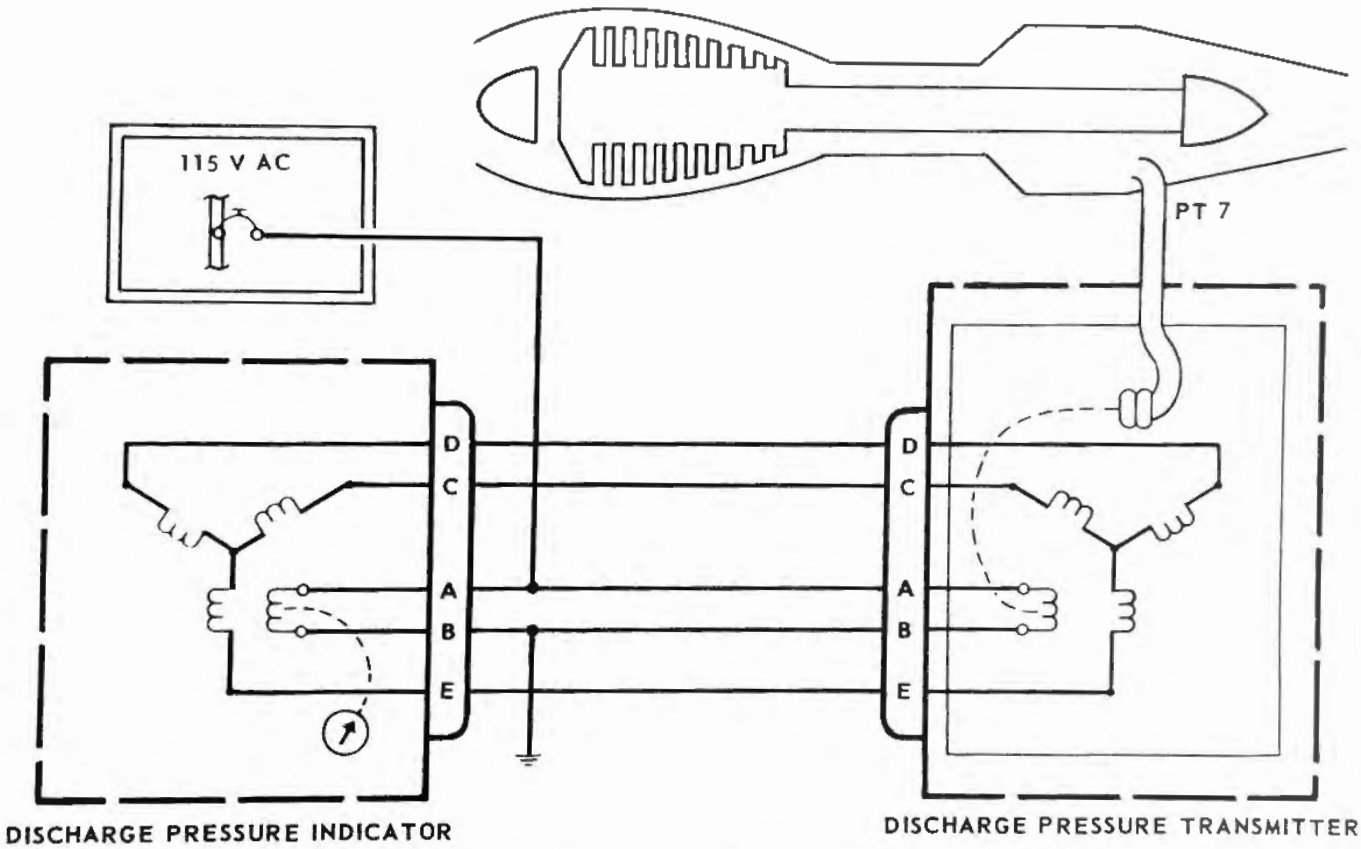

TURBINE
DISCHARGE
PRESSURE
TRANSMITTER
TYPICAL ALL FOUR ENGINES


TURBINE DISCHARGE PRESSURE
SENSING PROBE
TYPICAL ALL FOUR ENGINES

6. Operation

A. The system receives 115-volt a-c power through the "DISCHARGE PRESSURE & OIL QTY INDICATORS" circuit breakers on circuit breaker panels P1, P2, P3 and P4.

B. The turbine discharge pressure (Pt_7) is converted into an electrical signal by the turbine discharge pressure transmitter. The signals from the transmitter syncro provide an electrical output which operates the syncro receiver in the turbine discharge pressure indicator.

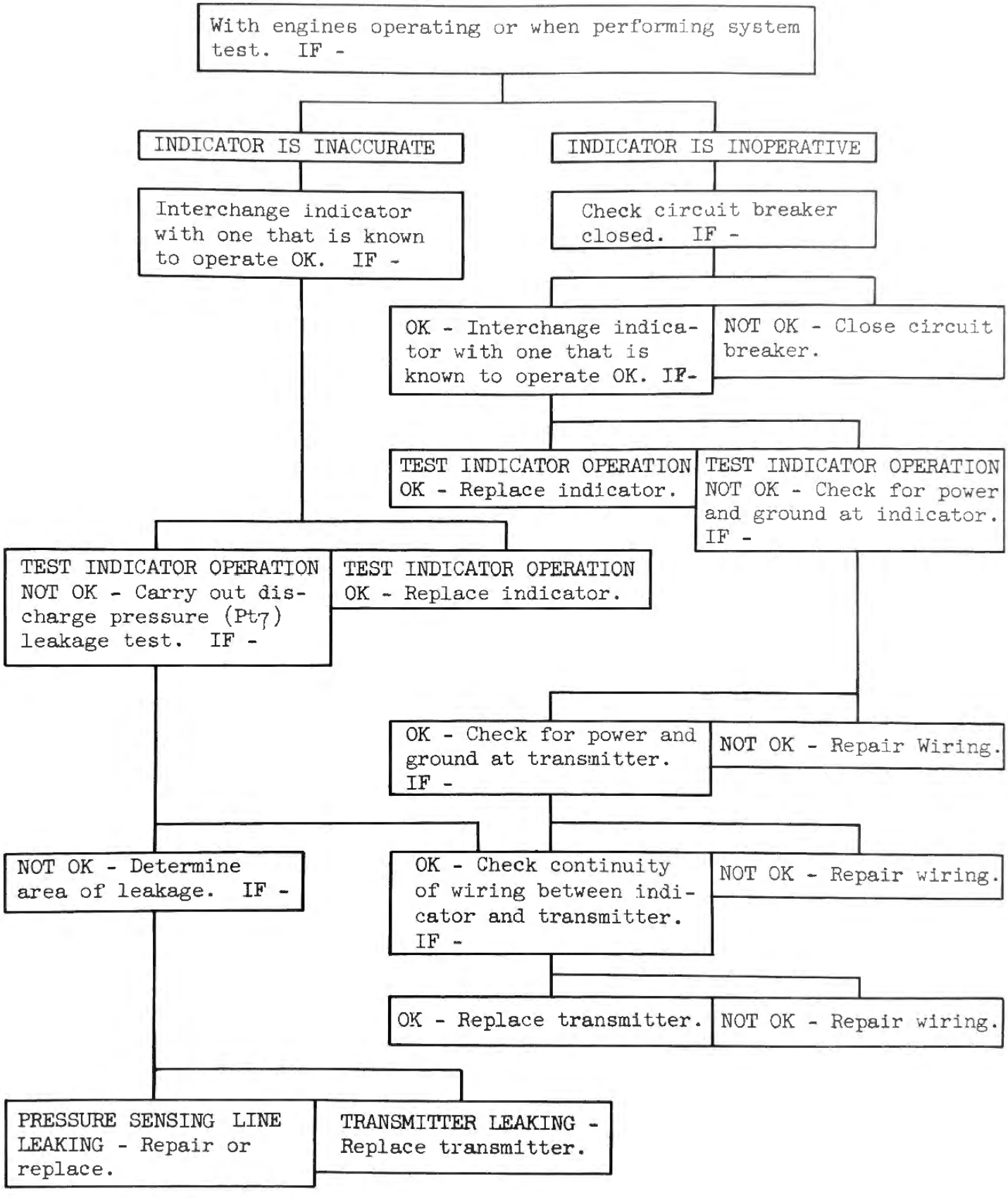


TYPICAL ALL FOUR ENGINES

Turbine Discharge Pressure Indicating System Schematic
Figure 2

END

TURBINE DISCHARGE PRESSURE INDICATING SYSTEM - TROUBLE SHOOTING



TURBINE DISCHARGE PRESSURE INDICATING SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Turbine Discharge Pressure Indicating System

A. Test Turbine Discharge Pressure Indicating System

(1) General

(a) The turbine discharge pressure transmitter and related sensing lines must be tested for leakage before performing an operation and accuracy test. Electrical power must be applied to the system for two minutes for warm up to prevent damage to the transmitter.

(b) The operation and accuracy test of the turbine discharge pressure indicating system may be accomplished by applying air pressure to the turbine discharge pressure transmitter, measuring this air pressure and comparing the measured value with the reading on the turbine discharge pressure indicator.

CAUTION: DO NOT EXCEED PRESSURE OF 105 INCHES OF MERCURY ABSOLUTE AT ANY TIME DURING THIS TEST. DAMAGE TO THE TRANSMITTER MAY RESULT.

(2) Equipment and Materials

(a) Air Pressure Source - adjustable 25 to 100 inches of mercury absolute

(b) Manifold Pressure Gage - sensitive, 0 to 100 inches of mercury absolute (With current calibration correction curve)

(c) External Power Source

(d) Valves, tubing and hose - as required to complete test set as shown in figure 201

(3) Test Turbine Discharge Pressure (Pt_7) Leakage

(a) Remove side cowl panels and removable top fairing. Refer to "Cowl Panels," Chapter 71.

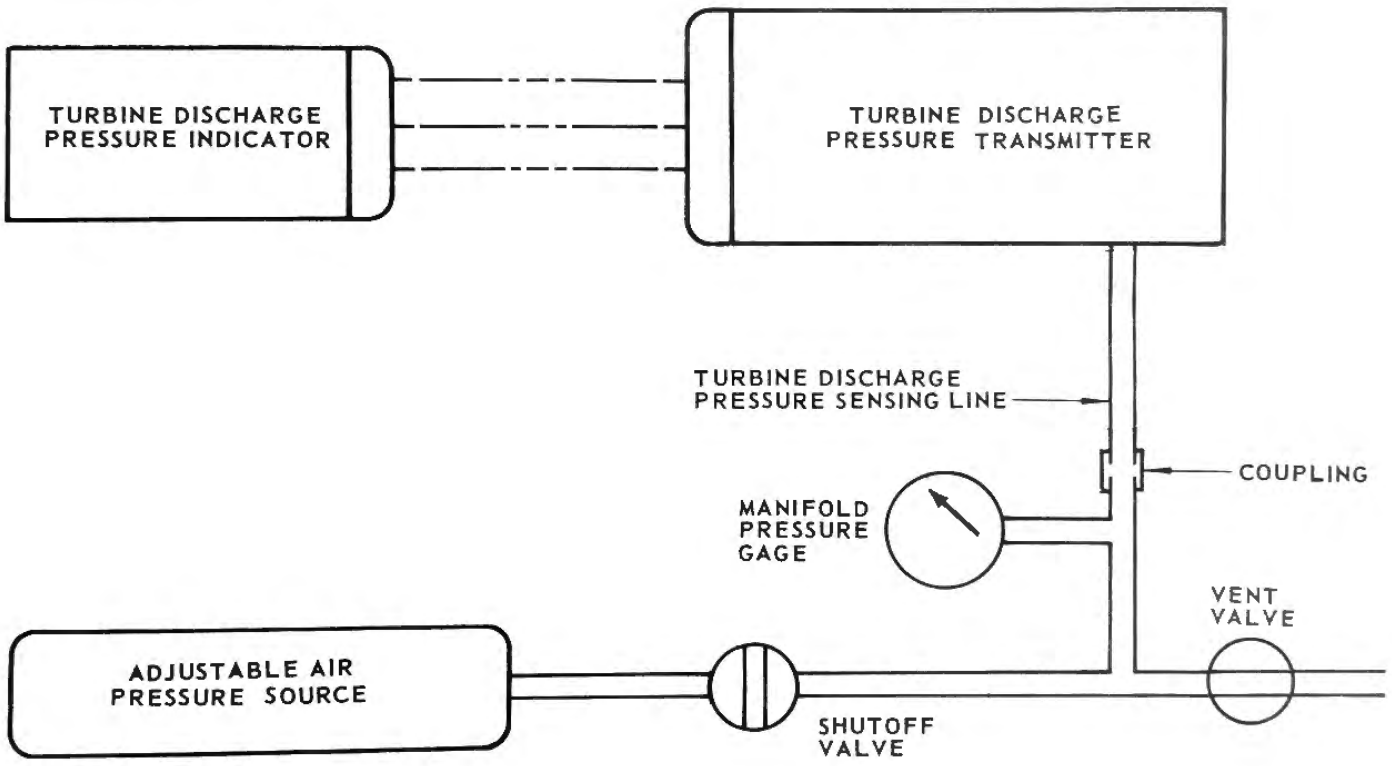
(b) Connect external power and close applicable "DISCHARGE PRESSURE & OIL QTY INDICATORS" circuit breaker.

(c) Disconnect turbine discharge pressure sensing line from turbine discharge pressure sensing manifold.

(d) Connect adjustable air pressure source to pressure sensing line. (See figure 201.)

(e) Slowly apply pressure of 100 inches of mercury absolute and close shutoff valve.

NOTE: Absolute pressure is the sum of gage pressure and barometric pressure. For example, if barometric pressure is 29.9 inches of mercury, the gage pressure required is 100 minus 29.9 or 70.1 inches of mercury.



Turbine Discharge Pressure Indicating System Test Connections
Figure 201

(f) Check that pressure leakage does not exceed 0.25 inch of mercury during five minute period.

(g) Relieve pressure slowly through test set vent valve.

(4) Test Operation and Accuracy

(a) Apply pressure to turbine discharge line as noted in table below.

Pressure applied to turbine discharge pressure line. Inches Hg. Absolute	Pressure on Turbine Discharge Pressure Indicator. Inches Hg. Absolute
30	30 ± 0.5
50	50 ± 0.5
70	70 ± 0.6
90	90 ± 0.6

(b) Turbine discharge pressure indicator on engine instrument panel should read the same pressure as applied within the tolerances noted in table.

(c) Turbine discharge pressure indicator pointer should operate smoothly over the dial; tap lightly before each reading.

(d) Adjust pressure to read 50 inches of mercury absolute on turbine discharge pressure indicator.

(e) Open applicable circuit breaker. Turbine discharge pressure indicator reading should not change.

(f) Increase test pressure.

(g) Close applicable circuit breaker; turbine discharge pressure indicator should read new higher value as set on test equipment.

(h) Close shutoff valve and slowly relieve pressure through test set vent valve.

(i) Disconnect adjustable air pressure source from turbine discharge pressure sensing line and connect line to turbine discharge pressure sensing manifold.

(j) Remove external power.

(k) Install removable top fairing and side cowl panels. Refer to "Cowl Panels," Chapter 71.

END

TEMPORARY REVISION No. 77-511
Insert in Chapter 77-5-1 facing page 201

REASON FOR ISSUE

CM 24695: Repositioning of engine fuel system pressure transmitter and PT. 7 transmitter.

TURBINE DISCHARGE ENGINE INDICATING PRESSURE TRANSMITTER - MAINTENANCE PRACTICES

Turbine Discharge Pressure Transmitter, Fig. 201: This figure is amended to show the new location of the PT. 7 transmitter in the position formerly occupied by the fuel Pressure Transmitter.

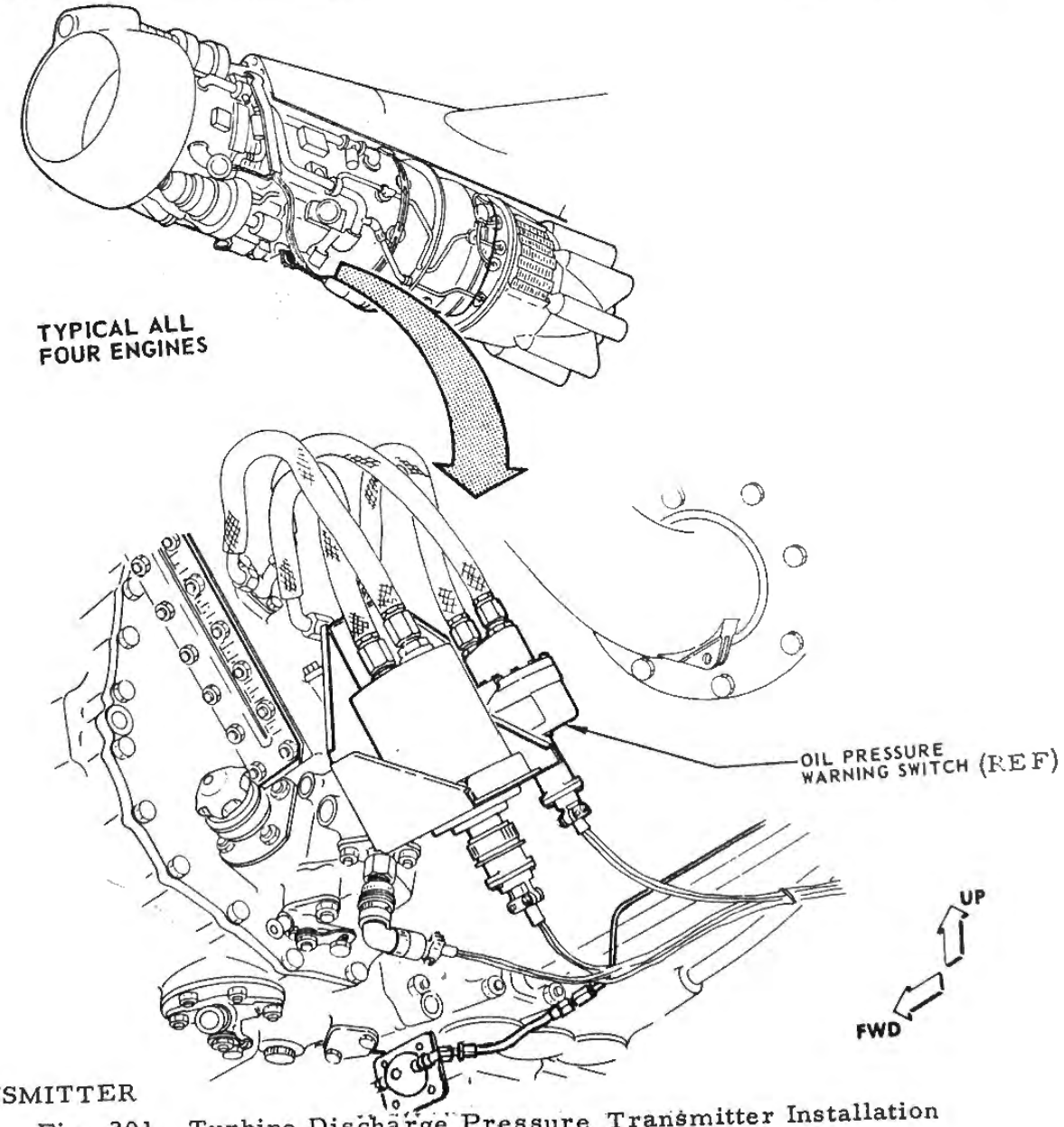


Fig. 201 Turbine Discharge Pressure Transmitter Installation

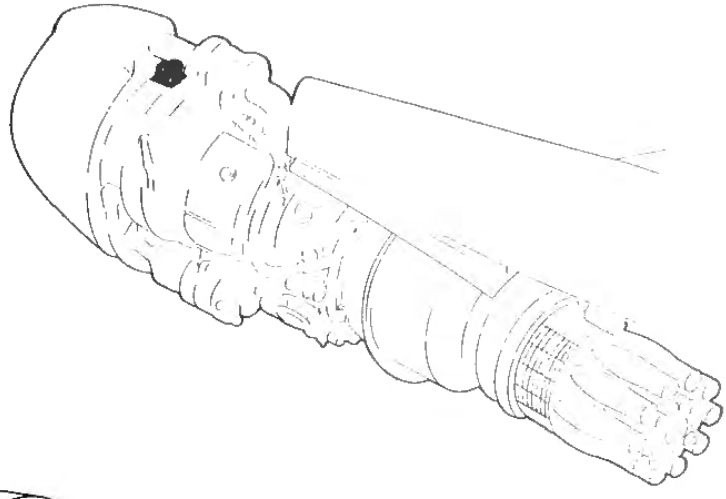
TURBINE DISCHARGE PRESSURE TRANSMITTER - MAINTENANCE PRACTICES

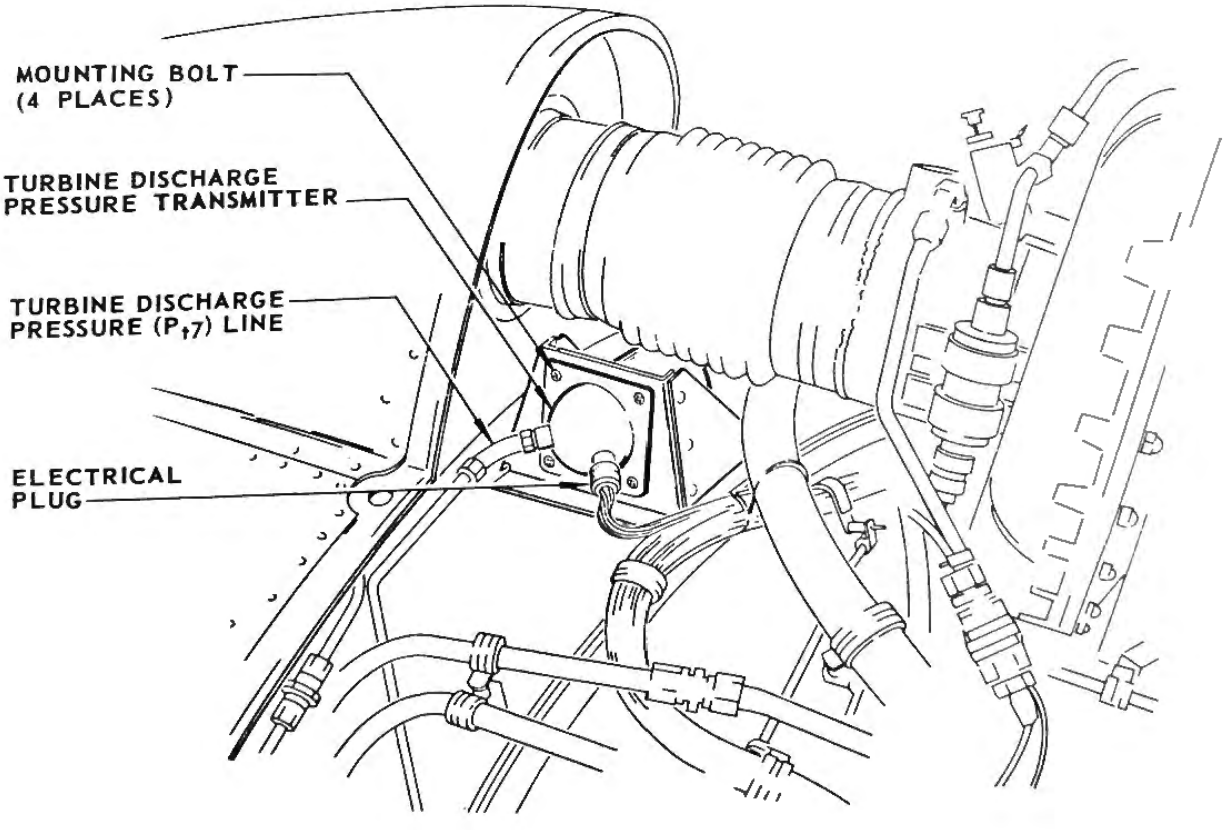
1. Removal/Installation Turbine Discharge Pressure Transmitter

   A. Remove Turbine Discharge Pressure Transmitter (See figure 201.)

      (1) Open applicable discharge pressure circuit breaker.

      (2) Remove removable top fairing. Refer to "Cowl Panels," Chapter 71.





Turbine Discharge Pressure Transmitter Installation
Figure 201

(3) Disconnect electrical plug.

(4) Disconnect discharge pressure (Pt_7) line from transmitter.

(5) Remove mounting bolts.

(6) Lift transmitter free of engine.

B. Install Turbine Discharge Pressure Transmitter

(1) Position turbine discharge pressure transmitter on engine as shown in figure 201.

(2) Install mounting bolts.

(3) Connect discharge pressure (Pt_7) line to transmitter.

(4) Connect electrical plug.

(5) Install removable top fairing. Refer to "Cowl Panels," Chapter 71.

(6) Close applicable discharge pressure circuit breaker.

END

TURBINE DISCHARGE PRESSURE SENSING PROBES - MAINTENANCE PRACTICES

1. Removal/Installation Turbine Discharge Pressure Sensing Probes

A. Remove Turbine Discharge Pressure Sensing Probes (See figure 201.)

(1) Remove side cowl panels. Refer to "Cowl Panels," Chapter 71.

(2) Disconnect pressure probe sensing line at probe and loosen line at turbine discharge pressure sensing manifold.

(3) Remove probe mounting bolts and pull probe free of engine.

B. Install Turbine Discharge Pressure Sensing Probes (See figure 201.)

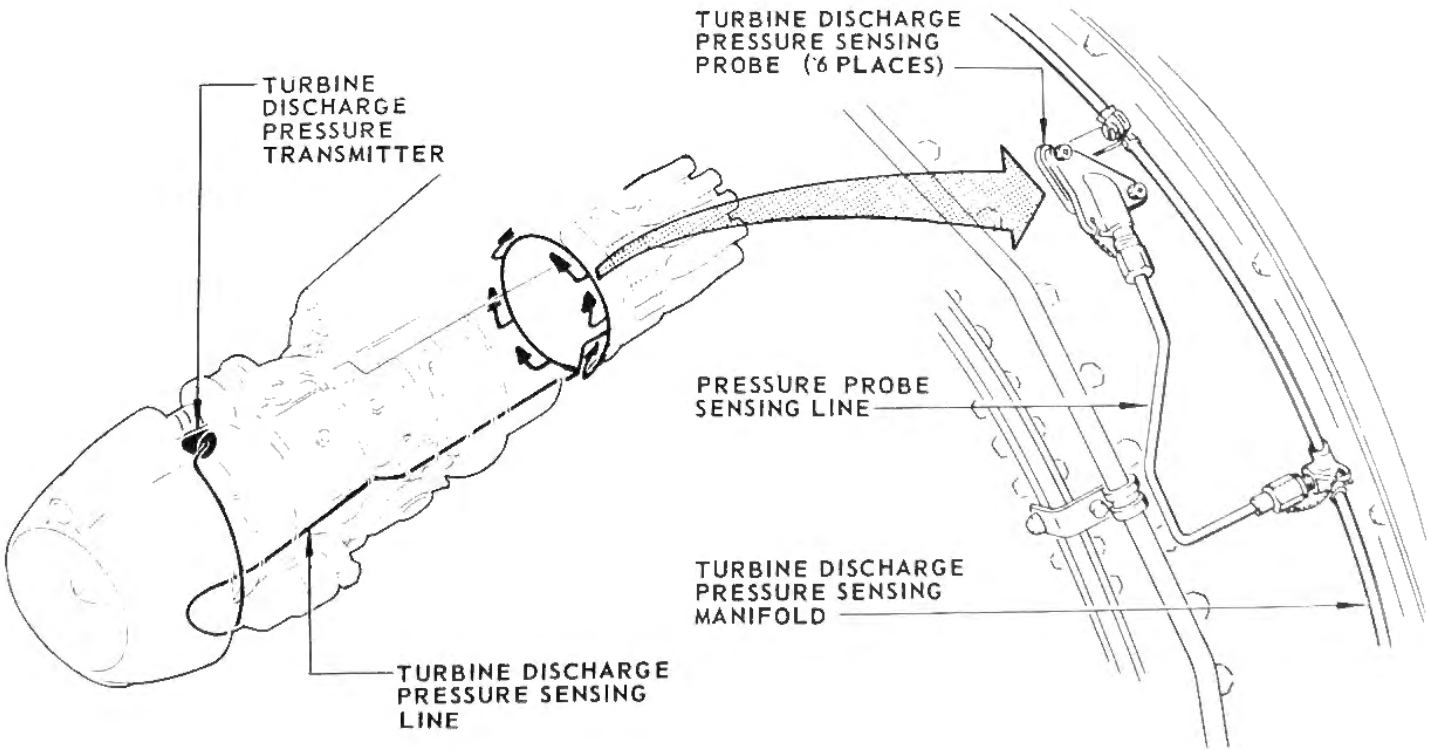
(1) Place turbine discharge pressure sensing probe in hole on periphery of engine discharge chamber.

(2) Align manifold bracket and probe.

(3) Install mounting bolts and secure with locknuts.

(4) Connect pressure probe sensing line to probe and tighten connection at turbine discharge pressure sensing manifold.

(5) Install side cowl panels. Refer to "Cowl Panels," Chapter 71.



Turbine Discharge Pressure Sensing Probe Installation
Figure 201

TURBINE DISCHARGE PRESSURE SENSING MANIFOLD - MAINTENANCE PRACTICES

1. Removal/Installation Turbine Discharge Pressure Sensing Manifold

A. Remove Turbine Discharge Pressure Sensing Manifold (See figure 201.)

(1) Remove side cowl panels. Refer to "Cowl Panels", Chapter 71.

(2) Disconnect sensing line leading to turbine discharge pressure transmitter at tee fitting.

(3) Disconnect pressure probe sensing lines at turbine discharge pressure sensing manifold.

(4) Separate left and right manifold segments at manifold tubing connections.

(5) Remove support clamps and free manifold segments from engine.

B. Install Turbine Discharge Pressure Sensing Manifold (See figure 201.)

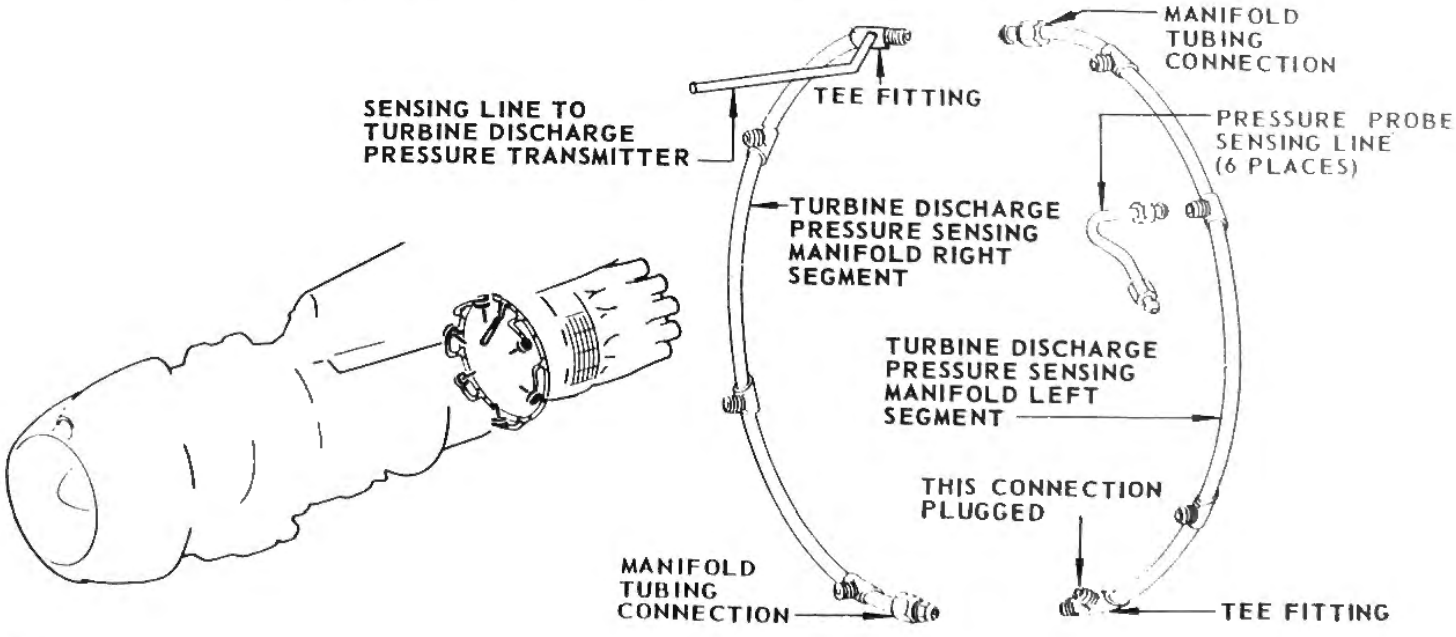
(1) Position turbine discharge pressure sensing manifold segments on engine and connect left and right segments at manifold tubing connections.

(2) Connect pressure probe sensing lines to manifold.

(3) Install support clamps.

(4) Connect sensing line leading to turbine discharge pressure transmitter at tee fitting.

(5) Install side cowl panels. Refer to "Cowl Panels", Chapter 71.



Turbine Discharge Pressure Sensing Manifold Installation
Figure 201

TEMPORARY REVISION No. 77-512
Insert in 77-11-0 facing page 3

REASON FOR ISSUE:-

Recording of vibration after the installation of an engine.

ENGINE VIBRATION INDICATING SYSTEM
DESCRIPTION AND OPERATION

5. Recording Method. add the following sub para.

B. Following the installation of an engine, vibration readings should be logged on the ground run at Idle, 80% N_2, 90% N_2, T/O r.p.m. This is to enable a comparison to be made any time during the engine life if increased vibration is suspected.

ENGINE PRESSURE RATIO INDICATING SYSTEM - DESCRIPTION AND OPERATION

1. General

A. The pressure ratio indicating system provides engine pressure ratio (P_{t7}/P_{t2}) readings in the control cabin. This information aids the pilot when selecting engine thrust.

B. The system for each engine consists of six exhaust pressure (P_{t7}) sensing probes around the periphery of the engine exhaust housing, one inlet pressure (P_{t2}) probe in the engine nose dome, a pressure ratio transmitter mounted in the nacelle strut and an indicator on the engine instrument panel. (See figure 1.)

2. Exhaust Pressure Sensing Probes

A. Engine exhaust pressure (P_{t7}) is detected by six probes extending into the engine exhaust chamber. These probes are connected to a common manifold.

3. Inlet Pressure Sensing Probe

A. Engine inlet (P_{t2}) is sensed by a probe similar to a pitot tube. This probe is mounted through the center of the nose dome so that the open end of the tube faces the air stream. The probe is heated by nose dome anti-icing air when the engine anti-icing system is in operation.

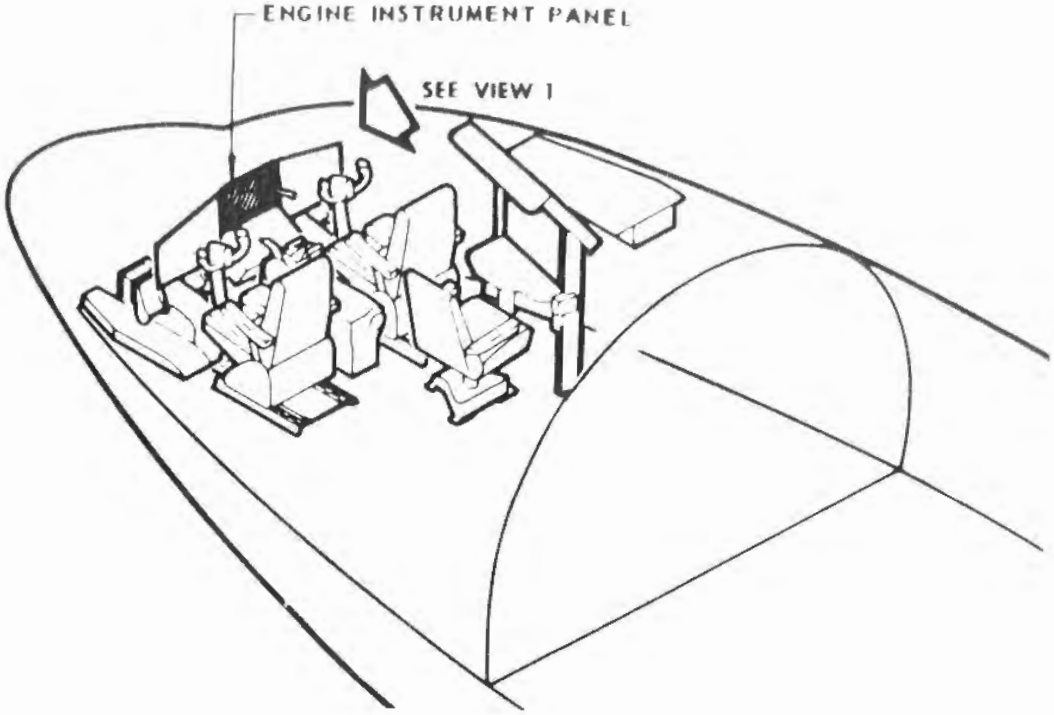
4. Exhaust Pressure Sensing Manifold

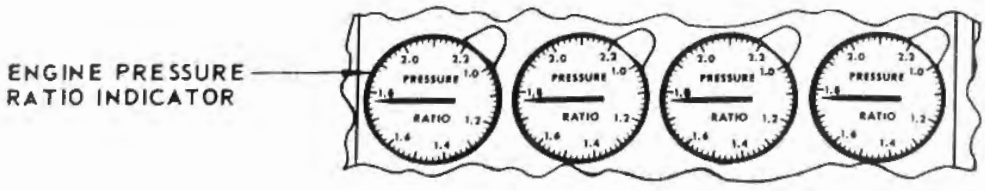
A. The exhaust pressure sensing manifold is made up of two segments of tubing mounted around the periphery of the exhaust casing. Three exhaust pressure sensing probes are connected to each manifold section. The manifold assembly averages the pressures sensed by the probes.

5. Engine Pressure Ratio Transmitter

A. The engine pressure ratio transmitter converts the exhaust pressure (P_{t7}) and the inlet pressure (P_{t2}) into a ratio, and generates three-phase electrical signals corresponding to pressure changes in the engine. It consists of two bellows (multicell diaphragms), a sensing mechanism, an amplifier, a motor-gear train, and a synchronous generator.

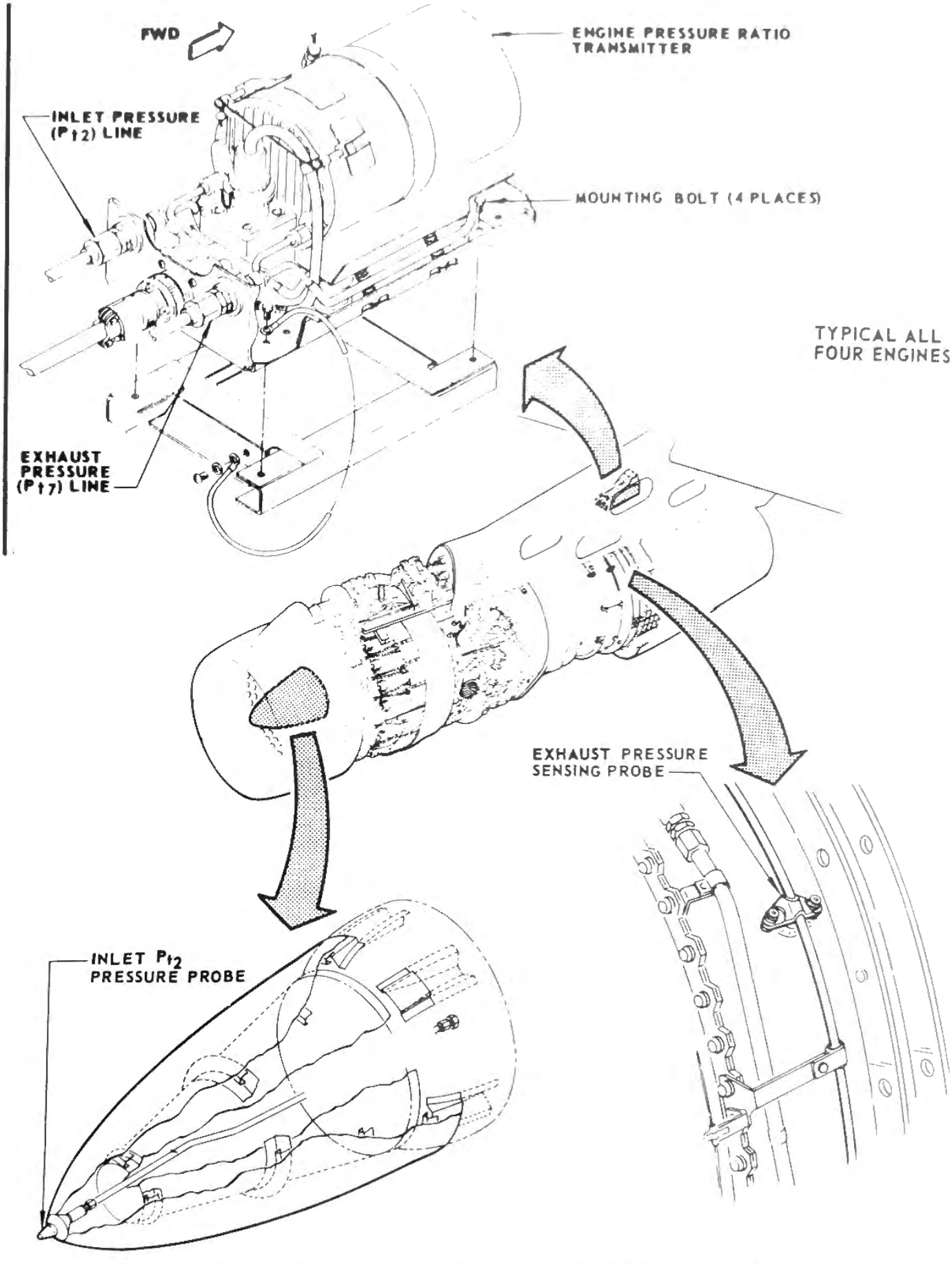
B. The engine exhaust (P_{t7}) and inlet (P_{t2}) pressures are applied to the bellows assembly of the transmitter. A change in either of these pressures cause differential bellows movement. The bellows movement effects the sensing mechanism which, with the aid of the amplifier and the motor-gear train, causes the generator rotor to rotate and generate three-phase electrical signals.





VIEW 1

Engine Pressure Ratio Indicating System Component Location
Figure 1 (Sheet 1 of 2)



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Engine Pressure Ratio Indicating System Component Location
Figure 1 (Sheet 2 of 2)

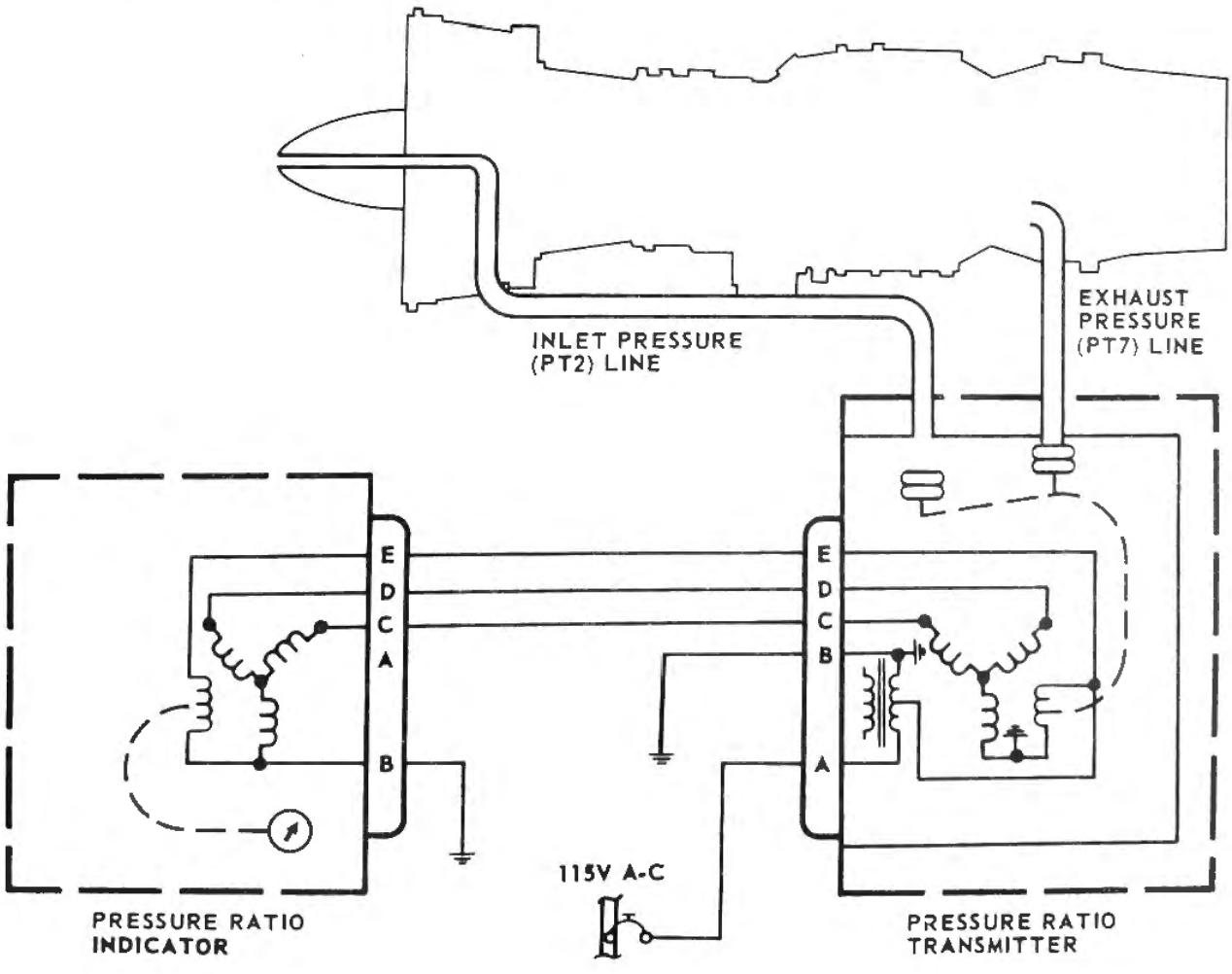
6. Engine Pressure Ratio Indicator

A. The engine pressure ratio indicator is located on the engine instrument panel. It contains a synchronous receiver which is actuated by the electrical signal received from the engine pressure ratio transmitter. The indicator shows the ratio between the exhaust and inlet pressures (P_{t7} and P_{t2}). (See figure 1.)

7. Operation

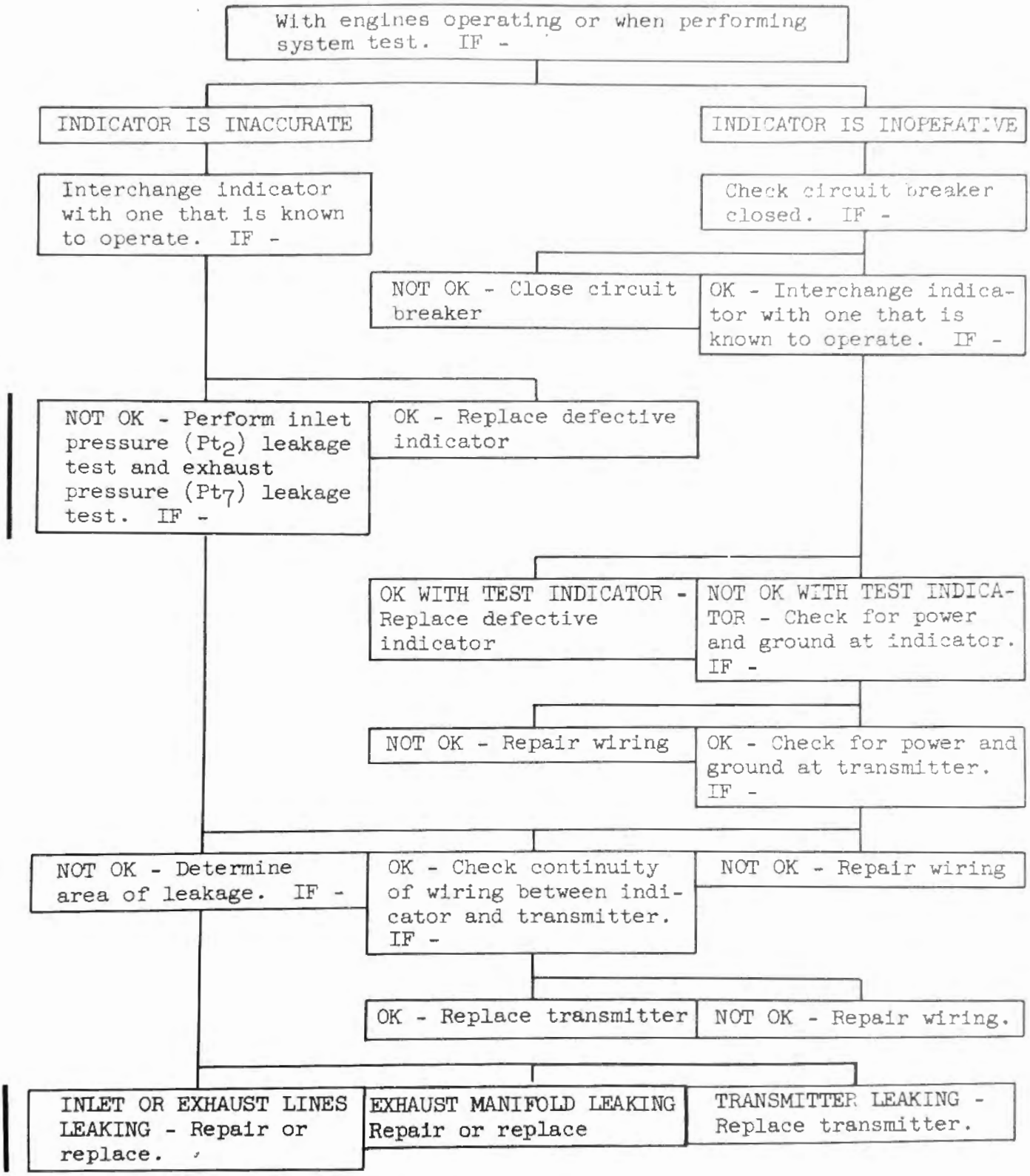
A. The system receives power from 115-volt a-c circuit breaker panels P1, P2, P3, P4, through the "OIL QTY & PRESS RATIO" circuit breakers.

B. The engine exhaust and inlet pressures are sensed by the pressure sensing probes. These pressures act on the bellows assembly of the pressure ratio transmitter, causing differential bellows movement whenever either of the pressures change. The relative bellows movement effects the sensing mechanism of the transmitter which, with the aid of the amplifier and motor-gear train, cause the generator rotor to rotate and generate three-phase electrical signals. The generated electrical signals are transmitted to a respective pressure ratio indicator over a three-wire system. The indicator converts the electrical signals into the pointer shaft rotation or indicator pointer movement corresponding to the pressure change in the engine. (Refer to figure 2.)



Engine Pressure Ratio Indication System Schematic
Figure 2

ENGINE PRESSURE RATIO INDICATING SYSTEM - TROUBLE SHOOTING



ENGINE PRESSURE RATIO INDICATING SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Engine Pressure Ratio Indicating System

A. General

(1) This system test will include the transmitter, indicator, inlet and exhaust pressure tubing and exhaust pressure manifold.

(2) The engine pressure ratio indicating system should be tested for leaks before performing operation and accuracy tests. Electrical power at 115-volts, 400-cps must be applied to the system for two minutes for warm up to prevent damage to the transmitter.

NOTE: An engine pressure ratio indicator reading which is slightly above 1.00 with the engine shutdown does not necessarily mean the system is inaccurate or that a component needs changing. Frictional losses may cause sticking of the pointer, and a calibration check should be made before changing items in the system.

B. Equipment and Materials

(1) An air pressure source must be provided with two individually regulated outlets, the pressure of which can be accurately set at pressures between 25.00 and 130.00 inches of mercury absolute. All pressures are to be monitored by pressure gages (with accuracy of ± 0.5%). Shutoff valves are to be installed on the pressure source side of the gages. (See figure 201.)

C. Test Engine Pressure Ratio Indicating System (See figure 201.)

CAUTION: DO NOT EXCEED 42 INCHES OF MERCURY ABSOLUTE ON THE INLET PRESSURE LINE, OR 70 INCHES OF MERCURY ABSOLUTE ON THE EXHAUST PRESSURE LINE WHILE THE LINES ARE CONNECTED TO THE TRANSMITTER. MAXIMUM PRESSURE DIFFERENTIAL SHALL NOT EXCEED 45 INCHES OF MERCURY ABSOLUTE AT ANY TIME DURING THESE TESTS AS PERMANENT DAMAGE TO THE TRANSMITTER MAY RESULT.

(1) Test Engine Inlet Pressure (P_{t2}) Line Leakage

(a) Remove engine right side cowl panel to obtain access to exhaust pressure tubing connection of engine pressure ratio system.

(b) Connect pressure hose from test apparatus to inlet pressure (P_{t2}) probe inlet port.

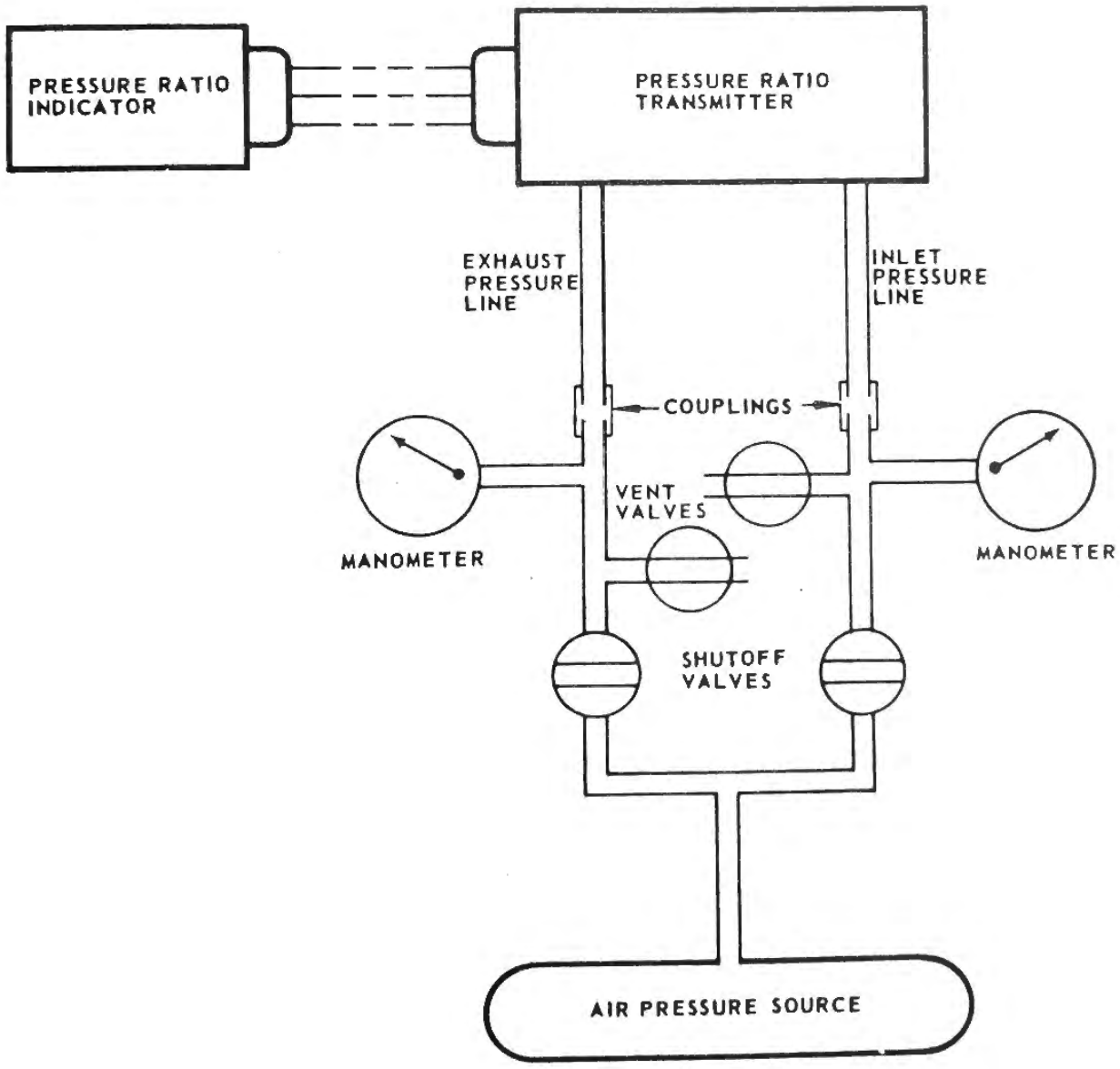
(c) Connect pressure tubing from test apparatus to inlet pressure fitting on transmitter. Pressure tubing to exhaust pressure side of transmitter is to be left open to atmosphere.

(d) Slowly apply pressure of 42 inches of mercury absolute then shut off valve to pressure source.

NOTE: Absolute pressure is the sum of gauge pressure and barometric pressure. For example, if barometric pressure is 30.1 inches of mercury, the gauge pressure required is 42 minus 30.1 or 11.9 inches.

(e) Check that pressure leakage does not exceed 0.25 inch of mercury during five minute period.

(f) Relieve pressure slowly through test set vent valve.



Engine Pressure Ratio Indicating System Test Connections
Figure 201

(2) Test Engine Exhaust Pressure (P_{t7}) Line Leakage

(a) Disconnect exhaust pressure tubing from exhaust pressure sensing manifold and attach test pressure hose to exhaust pressure tubing.

(b) Slowly apply pressure of 35 inches of mercury absolute to inlet pressure probe with vent capped.

(c) Slowly apply pressure of 70 inches of mercury absolute to exhaust pressure tubing, then close shutoff valve to pressure source.

(d) Check that pressure leakage does not exceed 0.25 inch of mercury during five minute period. (Volume of entrapped air in test system should not exceed 45 cu inches.)

(e) Reduce exhaust pressure tubing pressure below 50 inches of mercury before reducing the inlet pressure.

(3) Test Engine Exhaust Pressure (P_{t7}) Manifold Leakage

(a) Disconnect test pressure hose from exhaust pressure tubing and connect to the exhaust pressure manifold.

CAUTION: MAKE SURE THERE IS NO POSSIBILITY OF BLOWING AIR INTO EPR TRANSMITTER.

(b) Apply pressure approximately of 130 inches of mercury absolute (65 psia) to exhaust pressure manifold.

(c) Check exhaust pressure manifold, especially where connections made to individual probes, by applying soap and water solution.

NOTE: Air will be flowing through the P_{t7} probes continuously during this test, however, pressure differential will be sufficient to detect leaks in the manifold.

(d) If leaks are present, make repairs with assistance of local P & WA representative.

(e) Relieve test pressure and remove test pressure hoses.

(4) Test Operation and Accuracy

(a) Connect external electrical power to airplane and close "OIL QTY & PRESS RATIO" circuit breakers.

(b) Apply pressure to inlet pressure probe and exhaust pressure tube as shown on chart below:

ENGINE INLET PRESSURE In. Hg. A	PSIA	ENGINE EXHAUST PRESSURE In. Hg. A	PSIA	PRESSURE RATIO READINGS P_{t7}/P_{t2}
30.00*	14.73	66.00*	32.42	2.20 ± 0.010
35.00*	17.19	70.00*	34.38	2.00 ± 0.010
* Correct for barometric Pressures.				

(c) Engine pressure ratio indicator on engine instrument panel should read corresponding values given, within tolerances noted.

(d) Engine pressure ratio indicator pointer should operate smoothly over dial; tap lightly before each reading.

(e) Adjust test pressure source to obtain pressure ratio indication above 1.55 (± 0.05) on engine pressure ratio indicator.

(f) Open circuit breaker. Engine pressure ratio indicator reading should not change.

(g) With circuit breaker open, increase pressure ratio setting to approximately 1.85 ± 0.05 on test apparatus. Engine pressure ratio indicator reading should not change.

(h) Close circuit breaker. Pressure ratio indication should increase to new higher value.

(i) Relieve test pressure and remove test pressure hoses.

CAUTION: REDUCE EXHAUST PRESSURE BELOW 50 INCHES OF MERCURY BEFORE REDUCING INLET PRESSURE TO PREVENT TRANSMITTER DAMAGE.

(j) Connect exhaust pressure tubing to manifold fitting connection.

(k) On airplanes with P_{t2} probe mounted on engine strut, remove cap from aft end of P_{t2} probe.

(l) Install right side cowl panel.

ENGINE PRESSURE RATIO TRANSMITTER - MAINTENANCE PRACTICES

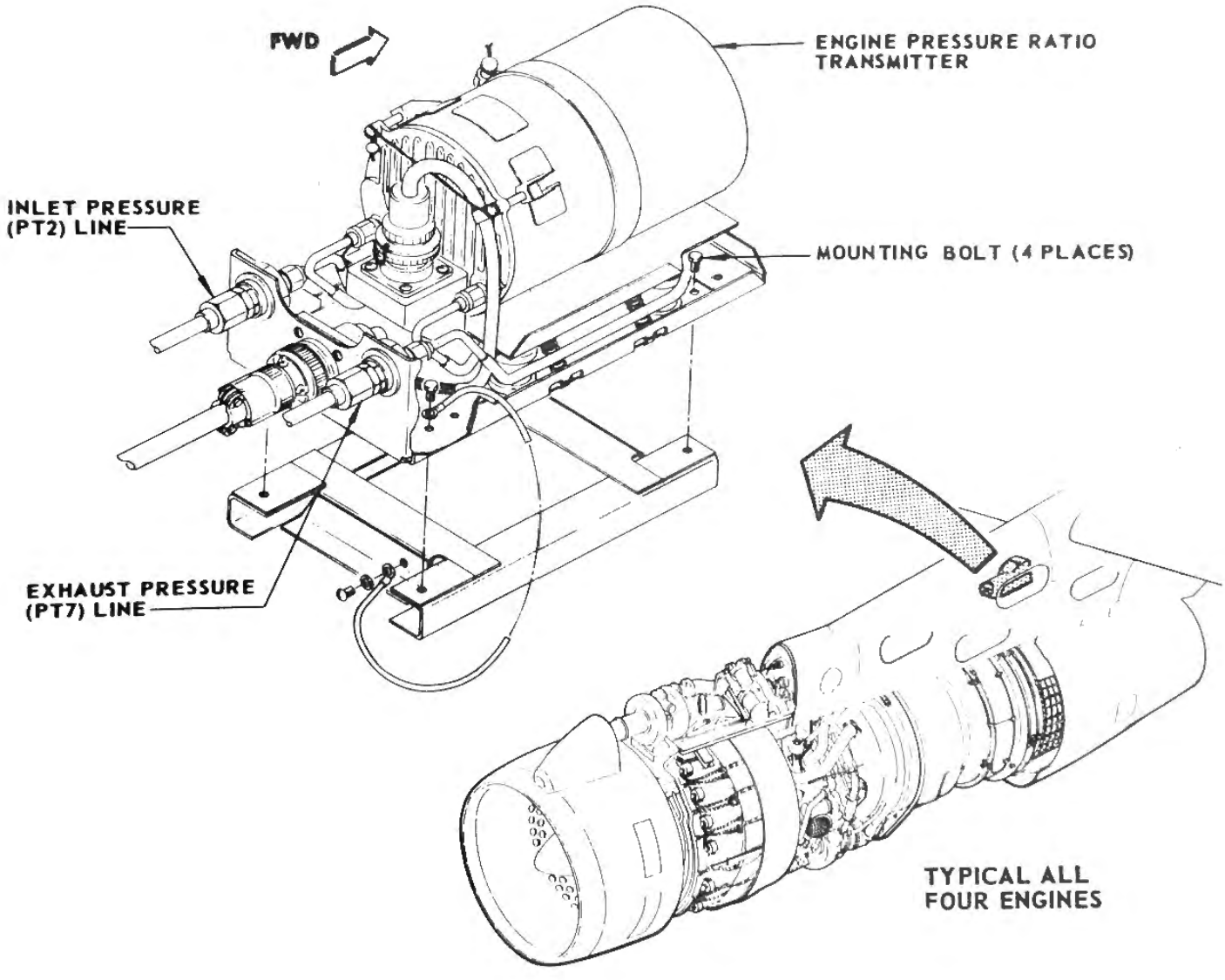
1. Removal/Installation Engine Pressure Ratio Transmitter

A. Remove Engine Pressure Ratio Transmitter (See figure 201.)

(1) Open applicable engine pressure ratio circuit breaker.

(2) Remove access panels on nacelle strut as indicated below.

Engine Nacelle Strut No.	Access Panels No. (Ref. Chapt. 12)
1 and 4	1742
2 and 3	1708



Engine Pressure Ratio Transmitter Installation
Figure 201

(3) Disconnect electrical plug on pressure ratio transmitter.

(4) Disconnect inlet (P_{t2}) and exhaust (P_{t7}) pressure lines at pressure connections on transmitter.

(5) Remove four mounting bolts and lift transmitter free of strut.

B. Install Engine Pressure Ratio Transmitter (See figure 201.)

(1) Lift engine pressure ratio transmitter into position.

(2) Install four mounting bolts holding transmitter assembly to bracket.

(3) Connect inlet (P_{t2}) and exhaust (P_{t7}) pressure lines to pressure connections on transmitter. Connect electrical plug to transmitter.

(4) Install access panels. Refer to Chapter 12 and Table above.

(5) Close applicable engine pressure ratio circuit breaker.

EXHAUST PRESSURE SENSING PROBES AND MANIFOLD - MAINTENANCE PRACTICES

1. Removal/Installation Exhaust Pressure Sensing Probes and Manifold

A. Remove Exhaust Pressure Sensing Probes and Manifold (See figure 201.)

(1) Remove side cowl panels. Refer to "Cowl Panels," Chapter 71.

(2) Disconnect clamps securing manifold to turbine case flange.

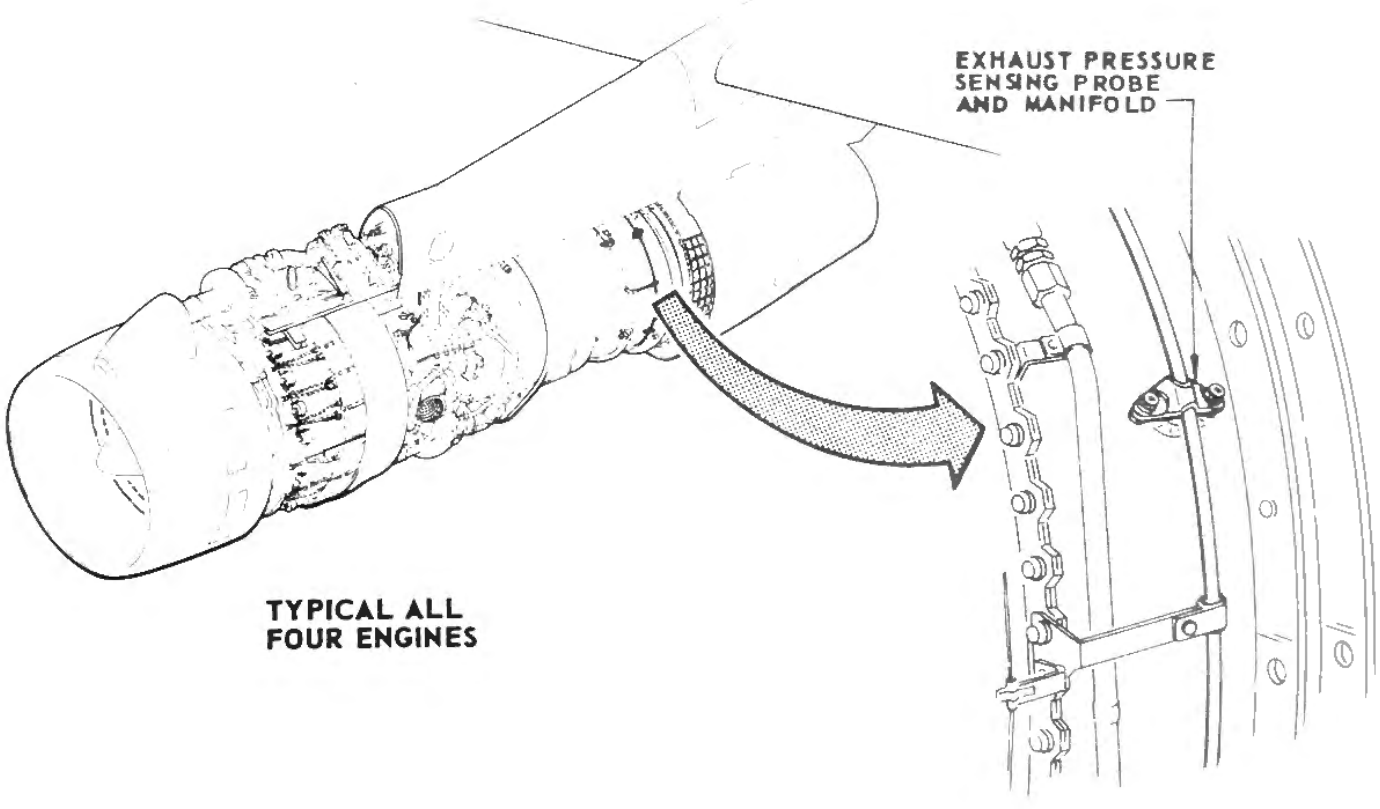
(3) Disconnect manifold union nuts at 6 o'clock and 12 o'clock.

(4) Disconnect branch line union nut at approximately 5 o'clock.

(5) Remove probe mounting bolts and pull either left or right manifold section free of engine.

(6) Repeat with other section of manifold.

(7) Remove probes from housings in exhaust casing.



Exhaust Pressure Sensing Probe and Manifold Installation
Figure 201

B. Install Exhaust Pressure Sensing Probes and Manifold (See figure 201.)

(1) Insert probes into housings around exhaust casing.

(2) Position one section of exhaust pressure sensing manifold around periphery of engine turbine chamber.

(3) Install probe mounting bolts and secure with locknuts.

(4) Repeat procedure for opposite manifold section.

(5) Tighten union nuts joining both halfs of sensing manifold together.

(6) Connect clamps securing manifold to turbine case flange.

(7) Tighten union nut joining branch line to manifold assembly.

(8) Install side cowl panels. Refer to "Cowl Panels," Chapter 71.

INLET PRESSURE SENSING PROBE - MAINTENANCE PRACTICES

EFFECTIVITY

AA 707-123B and QANTAS 707-138B

1. Removal/Installation Inlet Pressure Sensing Probe

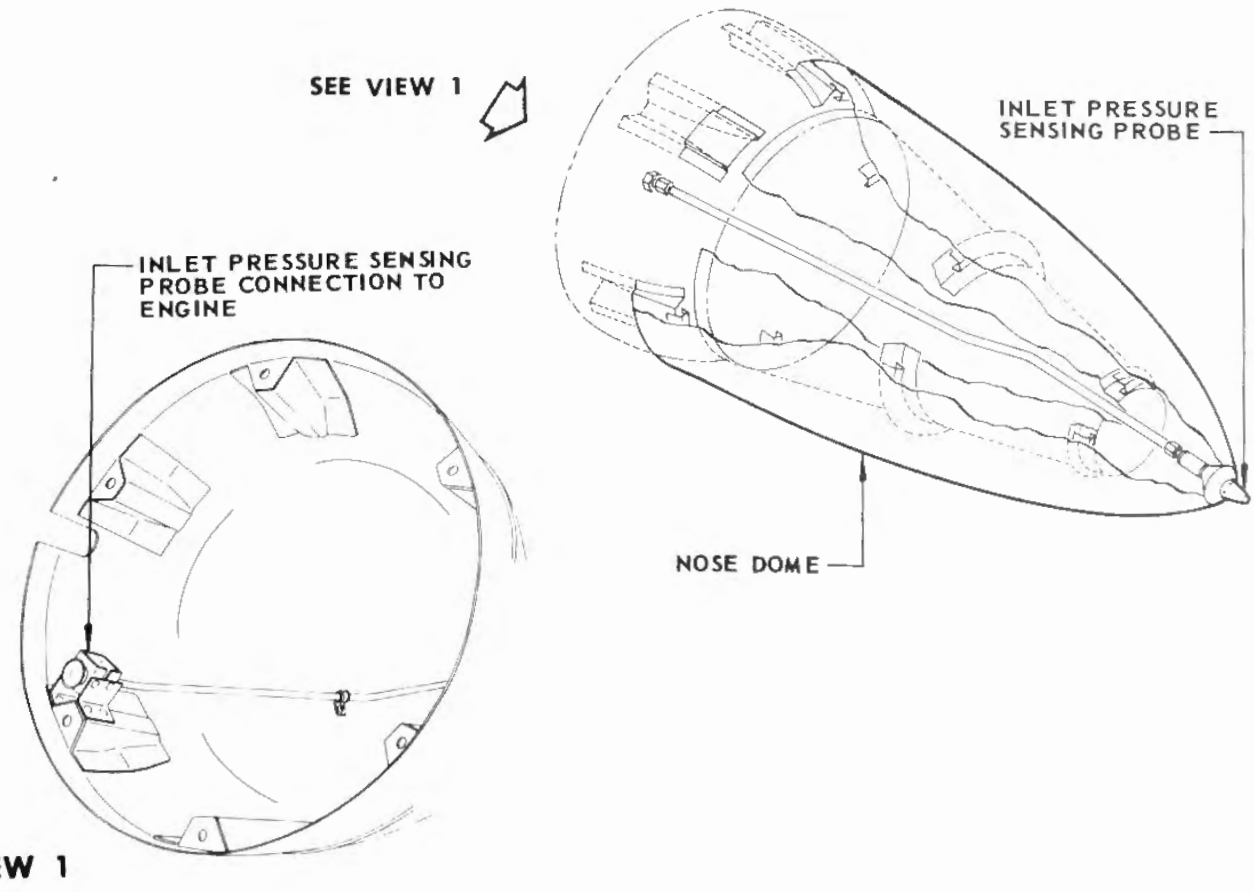
A. General

(1) The inlet pressure (P_{t2}) sensing probe (figure 201) is assembled to the engine nose dome and is removed and installed with the nose dome. Refer to Chapter 71, "Engine Nose Dome."

2. Inspection/Check Inlet Pressure Sensing Probe

A. Check Inlet Pressure Sensing Probe

(1) Examine the (P_{t2}) inlet air hole located at the front of the nose dome for damage. (See figure 201.) Check the probe to engine connection, located aft end of nose dome, for damage to connection thimble and ingress of foreign material into sensing tube.



Inlet Pressure Sensing Probe Installation
Figure 201

END

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - DESCRIPTION AND OPERATION

1. General

A. The engine exhaust gas temperature (EGT) indicating system measures and shows a reading of engine exhaust gas temperature on indicators located in the control cabin.

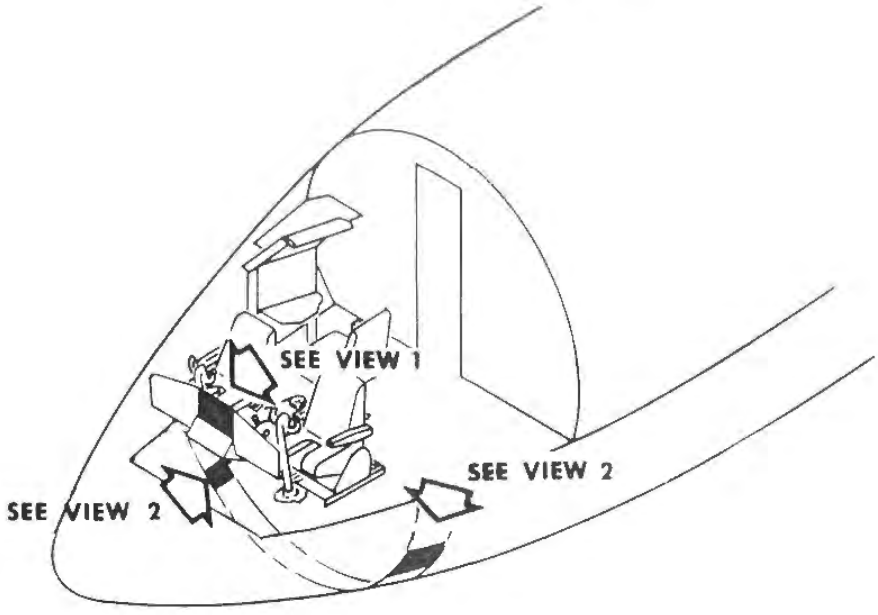
B. The engine exhaust gas temperature indicating system consists of twelve thermocouple elements grouped in pairs and enclosed in six probes arranged around the engine exhaust housing, one variable thermocouple resistor for each engine and four temperature indicators on the engine instrument panel.

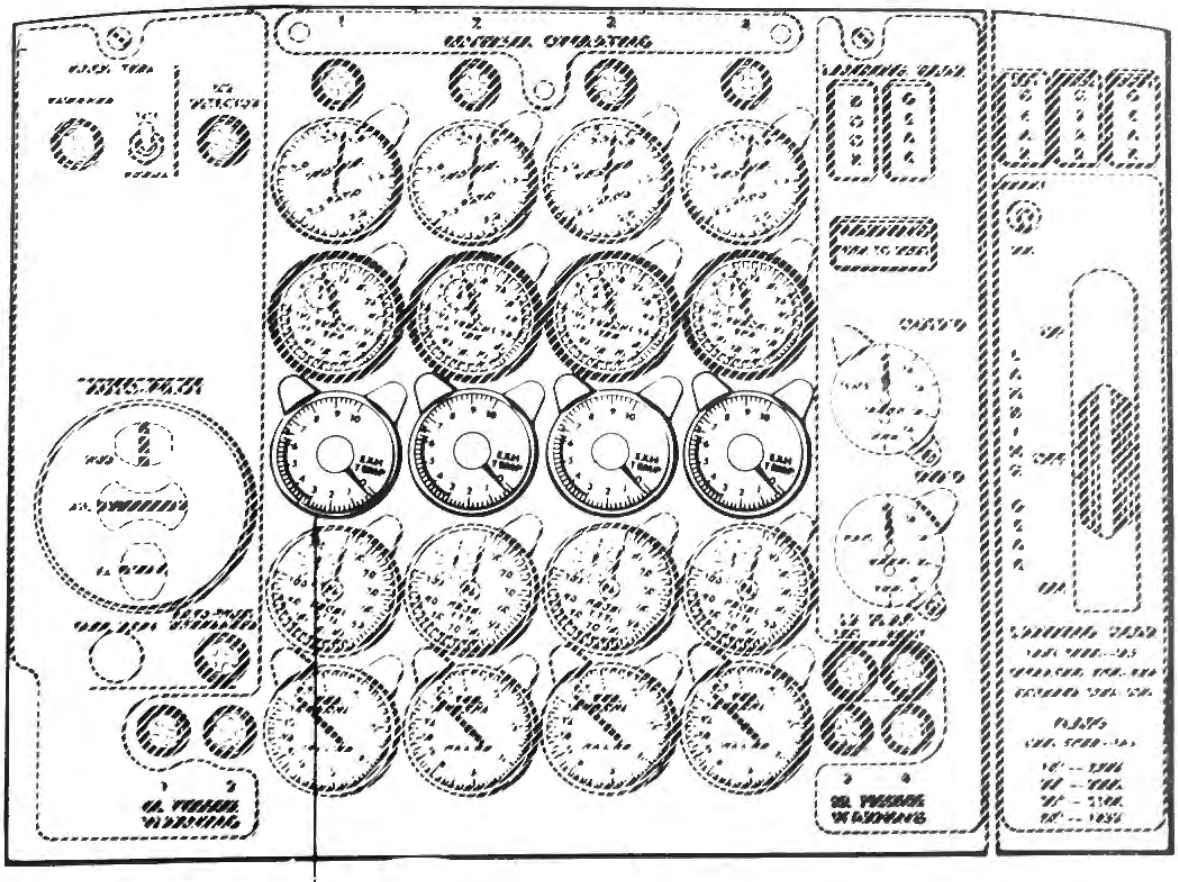
C. Engine exhaust gas temperature is sensed by the thermocouple elements. The heat of the exhaust gases causes the thermocouples to generate a d-c electrical signal which actuates the meter movement of the exhaust temperature indicator. Copper and constantan wires are used in the low temperature zone of the engine and chromel and alumel wires are used where higher temperatures are encountered. The variable resistance is included in the circuit to allow adjustment of the system.

2. Exhaust Gas Temperature Thermocouples

A. The exhaust gas temperature thermocouple is a thermo-electrical device which produces a d-c electrical signal for operation of the system. (See figure 2.)

B. Two thermocouples are enclosed in each sampling probe mounted on the engine exhaust housing with the probes projecting into the exhaust stream. Six thermocouples, one from each pair, are connected in parallel so that two wires carry the average of the exhaust gas temperature signals. The remaining one from each pair has separate wires in the thermocouple harness to allow selection of a signal from any one probe. The thermocouple junction and studs are made of chromel and alumel material. The alumel stud terminal (-) is larger than the chromel stud terminal (+). The polarity of the thermocouples is also indicated by a green paint spot near the negative terminal. Each probe is provided with four gas inlet holes and one gas discharge hole.



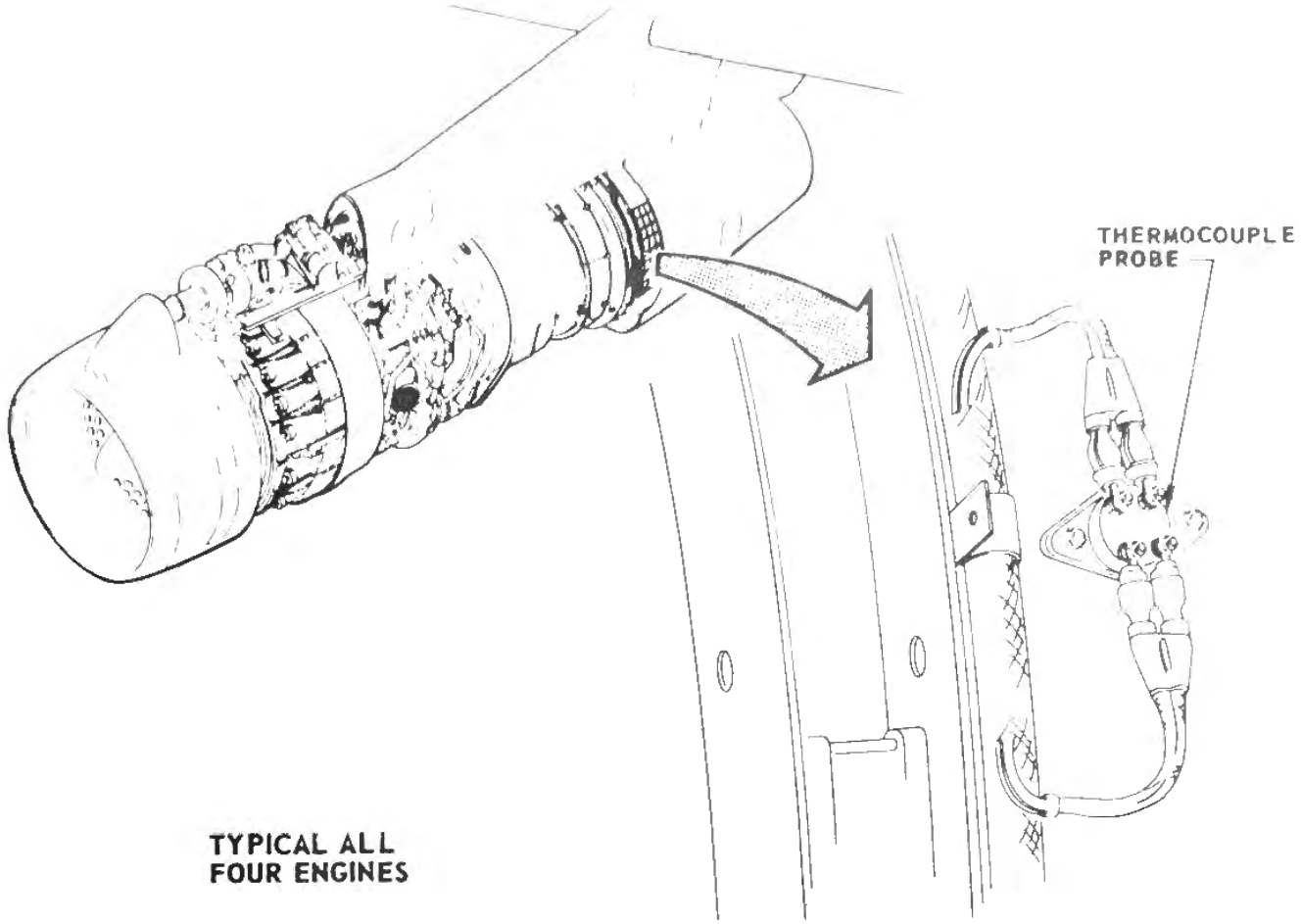


VIEW 1

ENGINE INSTRUMENT PANEL

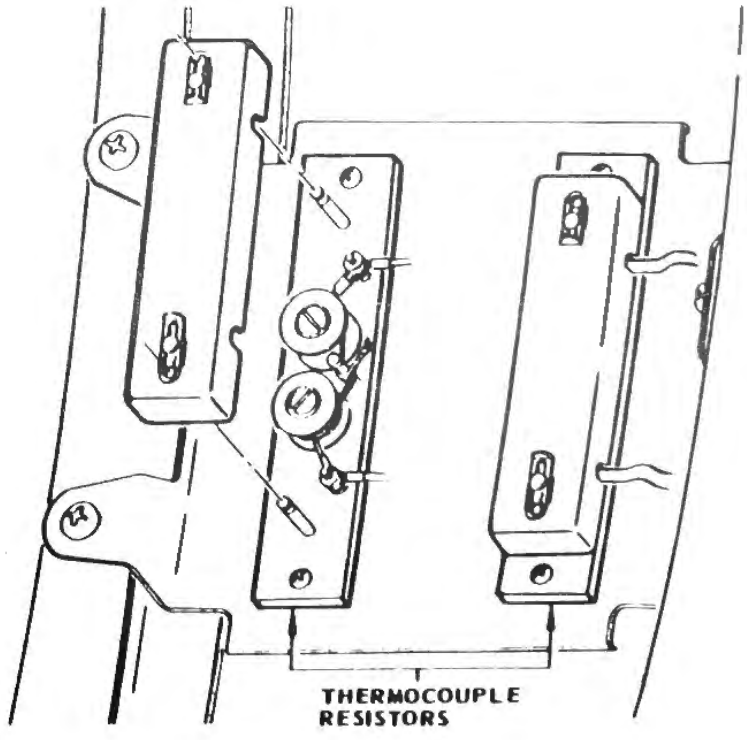
Exhaust Gas Temperature Indicating System Equipment Location
Figure 1 (Sheet 1 of 2)

(2)



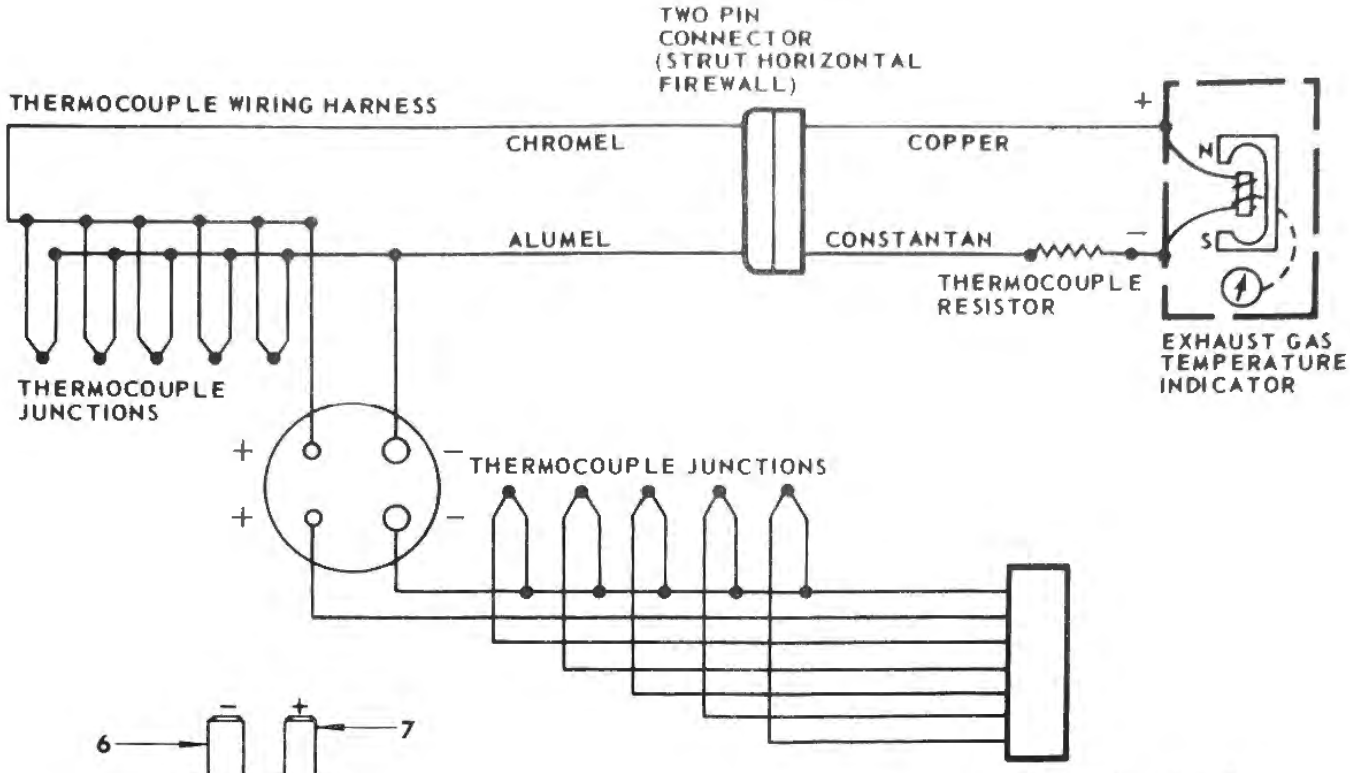
TYPICAL ALL FOUR ENGINES

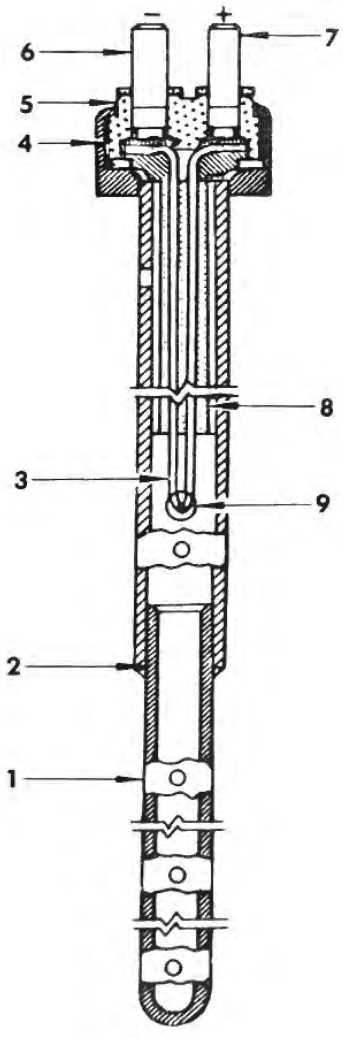
NOTE: RESISTORS FOR ENGINES NO. 1 AND NO. 2 ARE LOCATED IN LEFT SIDE OF LOWER NOSE COMPARTMENT. RESISTORS FOR ENGINES NO. 3 AND 4 ARE LOCATED IN RIGHT SIDE OF LOWER NOSE COMPARTMENT. RIGHT SIDE RESISTORS (ENG 3 AND 4) FOR AIRPLANES VH-EBL AND ON, ARE LOCATED ON THE J23 RELAY SHIELD.



VIEW 2

Exhaust Gas Temperature Indicating System Equipment Location
Figure 1 (Sheet 2 of 2)





1 SHIELDING ASSEMBLY
2 TUBE-EXTENSION
3 CONDUCTOR
4 SHELL
5 BLOCK-TERMINAL
6 NEGATIVE STUD
7 POSITIVE STUD
8 INSULATION
9 JUNCTION

THERMOCOUPLE PROBE ASSEMBLY
(SHOWING ONE THERMOCOUPLE)

Exhaust Gas Temperature Indicating System Circuit
Figure 2

3. Exhaust Gas Temperature Thermocouple Resistor

A. The exhaust gas temperature thermocouple resistor adjusts circuit resistance values of the exhaust gas temperature indicating system. The elements of the resistor are two spools of No. 24 constantan wire with a resistance of 8.0 (+10% - 0%) ohms for each spool before adjustment. On airplanes VH-EBA through VH-EBK, the resistors are mounted on the lower nose compartment, fuselage walls, two on each side of the airplane. On airplanes VH-EBL and on, the resistors for engines No. 1 and No. 2 are mounted on the lower nose compartment left side fuselage wall. The resistors for engines No. 3 and No. 4 are mounted on J23 relay shield, located on the right side of the lower nose compartment.

4. Exhaust Gas Temperature Indicator

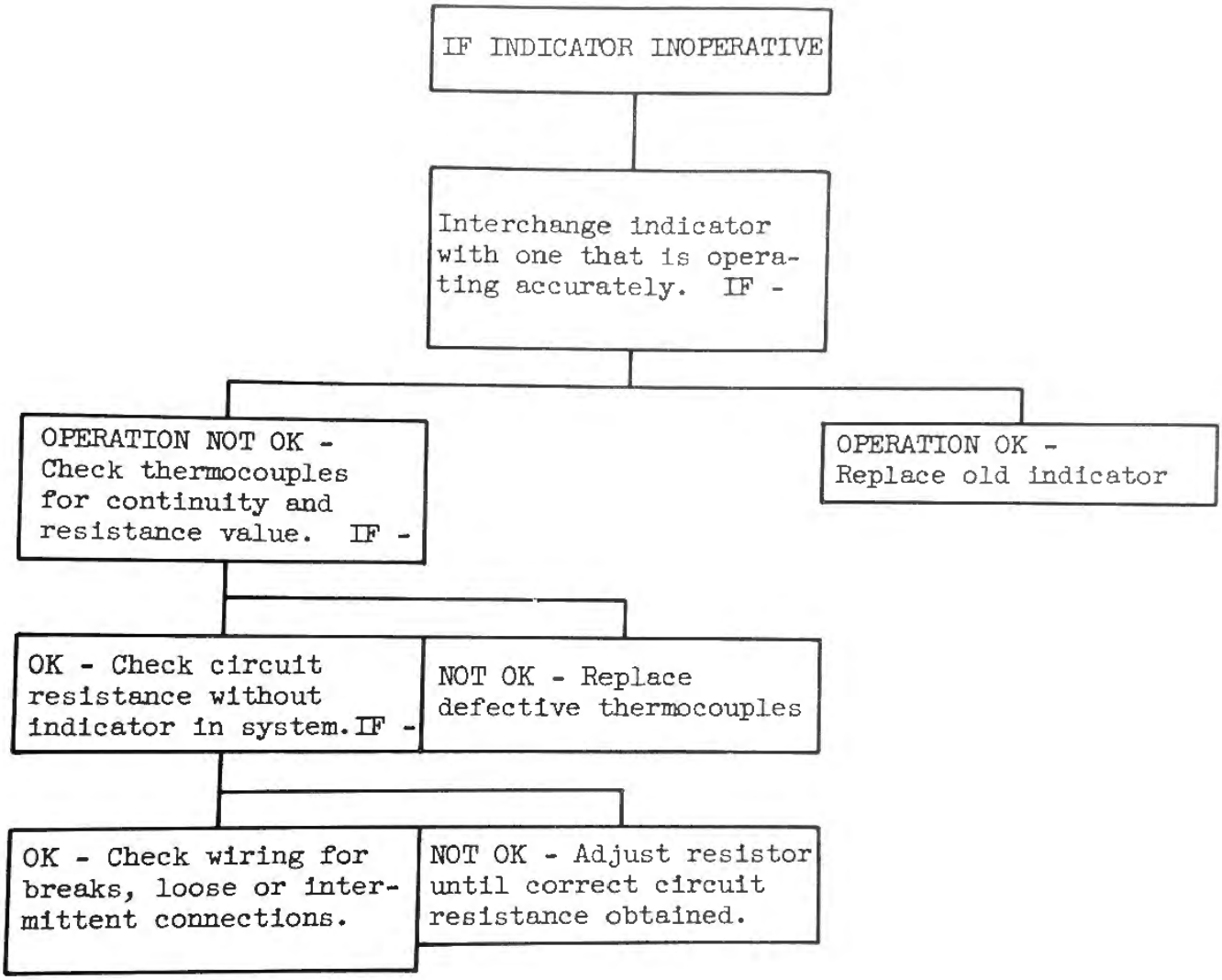
A. The exhaust gas temperature indicator is a moving coil sensitive voltmeter. Four indicators, one for each engine, are mounted on the engine instrument panel. The instruments have two terminals in the back of the case marked plus (+) and minus (-). These two terminals connect the meter coils inside the unit to the thermocouple circuit. A screwdriver operated pointer adjustment on the back of the indicator allows approximately a 55° adjustment range at 700°C. The instrument dial indicates a temperature range from 0° to 1000°C, with normal and dangerous operating temperatures marked.

5. Exhaust Gas Temperature Thermocouple Harness and Lead

A. One part of the exhaust gas temperature thermocouple harness averages the electrical output from six thermocouples by combining the individual signals in a parallel circuit which supplies the exhaust gas temperature indicator. The remaining wires in the harness take signals from the six other thermocouples to a test receptacle on the fireseal at the right side of the engine. This receptacle is capped off and the circuit is used for test purposes only.

B. The thermocouple harness consists of a flexible electrical conduit mounted on the outer circumference of the engine exhaust housing. The harness has a two-wire averaging circuit lead fastened to the engine with clips and routed forward through the engine fireseal to an electrical disconnect plug located at the engine strut firewall. A second outlet from the thermocouple harness terminates at the electrical test receptacle located at 5 0'clock on the engine fireseal.

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - TROUBLE SHOOTING



EXHAUST GAS TEMPERATURE INDICATING SYSTEM - MAINTENANCE PRACTICES

1. Adjustment Test Exhaust Gas Temperature Indicating System

A. General

(1) The exhaust gas temperature (EGT) indicating system is tested using a wheatstone bridge and an ohmmeter. Tests include measurements of circuit resistance and insulation resistance.

B. Equipment and Materials

(1) Wheatstone resistance bridge capable of measuring resistance to ± 0.1 ohm at 22 ohms.

(2) Low voltage ohmmeter capable of measuring resistance of 100,000 ohms. Meter should utilize less than 40 volts (dc) and should have an accuracy of five percent.

C. Test Exhaust Gas Temperature Indicating System Resistance

(1) Disconnect averaging circuit leads from exhaust gas temperature indicator on engine instrument panel.

(2) Attach disconnected leads to Wheatstone Bridge and measure circuit resistance of system. Resistance reading should be as shown.

SYSTEM RESISTANCE (OHMS)	AMBIENT TEMPERATURE °C
22.00 (± 0.1)	20° ± 5°
21.95 (± 0.1)	10° ± 5°
21.90 (± 0.1)	0° ± 5°

NOTE: If resistance is not within tolerance, check circuit for loose, corroded or shorted connections and defective thermocouple probes.

(3) Adjust resistor spool to bring circuit resistance within specified tolerance, if required.

(4) Remove Wheatstone Bridge from averaging circuit leads, and reconnect leads to indicator.

D. Test Insulation Resistance

(1) Check averaging circuit leads from indicator to engine fireseal for shorts to ground.

(a) Disconnect thermocouple averaging circuit leads from exhaust gas temperature indicator on engine instrument panel.

(b) Open left cowl panel on engine.

(c) Disconnect thermocouple averaging circuit connector forward of engine fireseal.

1) On engines fitted with Bendix connector, disconnect plug. (See figure 201, detail A)

2) On engines fitted with terminal type connector, remove teflon tape and disconnect terminals. (See figure 201, detail B)

(d) Place one ohmmeter terminal in contact with fireseal connector socket "A" or alumel terminal, and ground other ohmmeter terminal.

(e) Check averaging circuit lead from engine fireseal to indicator for shorts to ground. Resistance shall not be less than 100,000 ohms.

(f) Repeat steps (d) and (e) using fireseal connector socket "B" or chromel terminal.

(g) Connect thermocouple averaging circuit leads to indicator.

(2) Check exhaust gas temperature thermocouple harness and leads for shorts to ground.

(a) Place one ohmmeter terminal in contact with averaging circuit fireseal connector pin "A" or alumel terminal, and other ohmmeter terminal to stainless steel wire braid.

(b) Measure resistance. Resistance shall not be less than 50,000 ohms.

(c) and (d) Deleted.

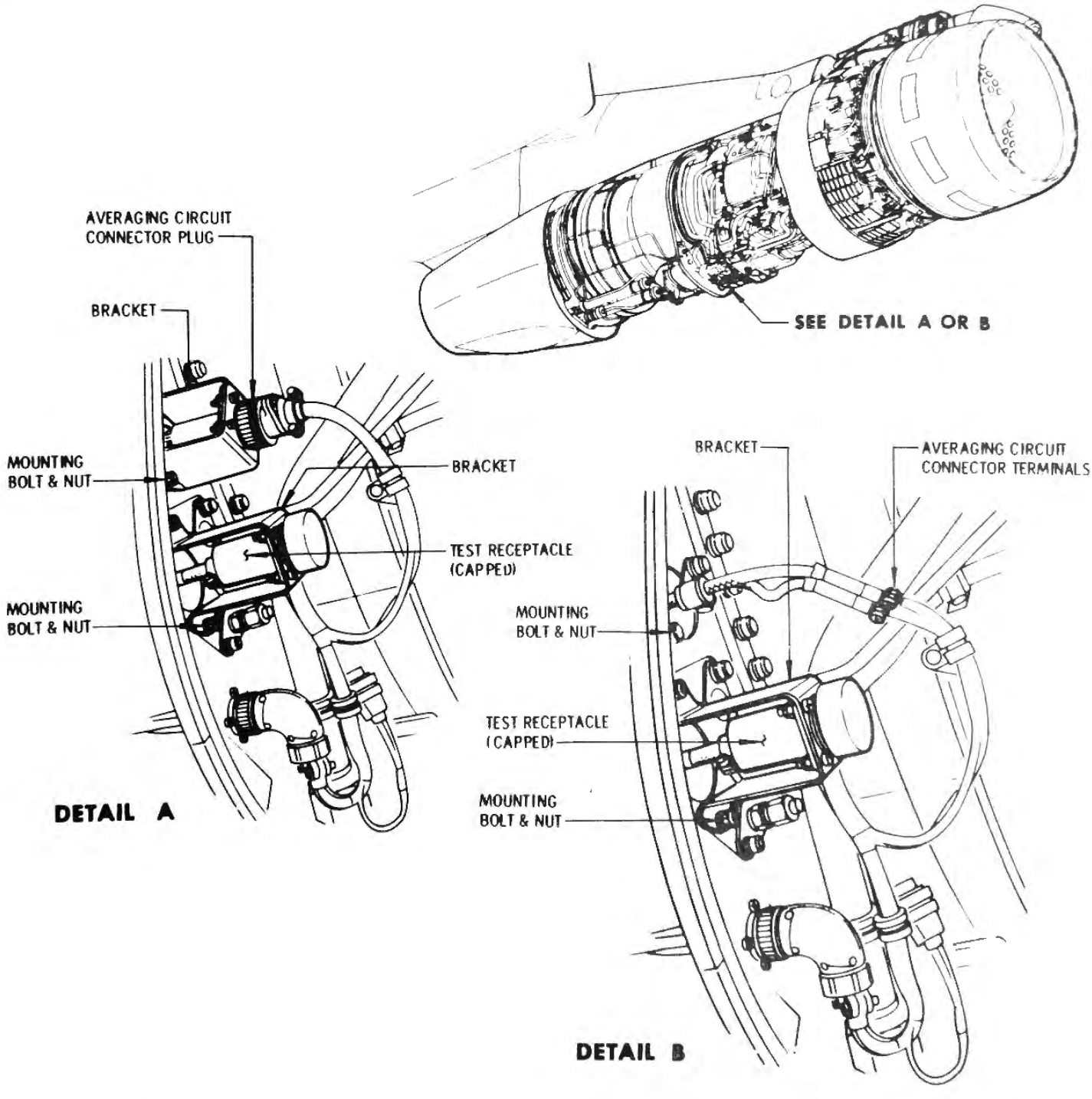
(e) If measured resistance is not at least 50,000 ohms, for further action refer to section 77-16-21, "EXHAUST GAS TEMPERATURE THERMOCOUPLE HARNESS AND LEAD - MAINTENANCE PRACTICES."

(f) Connect averaging circuit connector forward of engine fireseal.

1) On engines fitted with Bendix connector, connect plug.

2) On engines fitted with terminal type connector, connect terminals and wrap connection with teflon tape.

CAUTION: BE SURE THERE IS ENOUGH INSULATING MATERIAL BETWEEN THE TWO SETS OF CONNECTED TERMINALS TO PREVENT SHORTING OUT THE SYSTEM.



2 Exhaust Gas Temperature Thermocouple Harness Engine Fireseal Connectors
Jun 15/63 Figure 201

EXHAUST GAS TEMPERATURE THERMOCOUPLE RESISTOR - MAINTENANCE PRACTICES

1. Adjustment/Test Exhaust Gas Temperature Thermocouple Resistor

   A. General

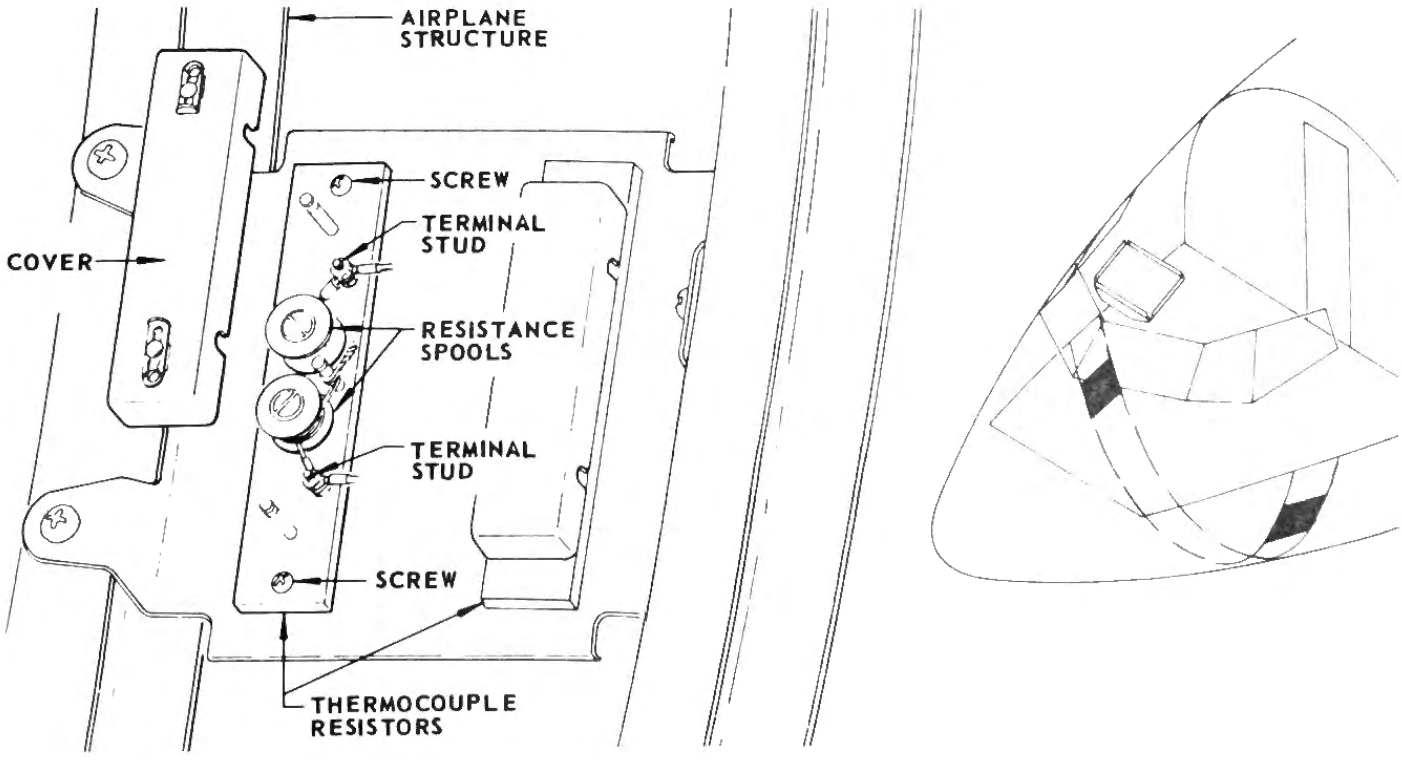
      (1) The exhaust gas temperature thermocouple resistor is adjusted by shortening the resistance wire on the spools. Circuit resistance, excluding indicator, must be 22.00 (± 0.1) ohms. Total resistance of circuit including indicator is approximately 55 ohms. If it is necessary to increase circuit resistance, a new resistor must be installed and correctly adjusted. (See figure 201.)

   B. Adjust Exhaust Gas Temperature Thermocouple Resistor

      (1) Remove exhaust gas temperature indicator from instrument panel.

      (2) Remove wiring from indicator. Make good electrical connection between the two conductors on airplane wiring side of disconnect by bolting terminals together.

      (3) Obtain access to thermocouple resistors for engines No. 1 and No. 2 by folding back the insulation in left lower nose compartment. Access to the thermocouple resistors for engines No. 3 and 4 is in right lower nose compartment opposite those for engines No. 1 and 2. For airplanes VH-EBL and on, engine No. 3 and 4 resistors are on J23 relay shield in right lower nose compartment.



Exhaust Gas Temperature Thermocouple Resistor Installation
Figure 201

(4) Adjust resistor by unwinding resistor wire and measuring circuit resistance with Wheatstone Bridge as turns of wire are removed. Wire resistance is approximately 0.73 ohm per foot.

(5) When correct circuit resistance of 22.00 (± 0.10) ohms is obtained, silver-solder resistance wire ends together.

(6) Wind excess wire around post between resistor spools.

(7) Replace resistor cover.

(8) Replace cabin insulation.

(9) Install exhaust gas temperature indicator on engine instrument panel.

END

EXHAUST GAS TEMPERATURE THERMOCOUPLES - MAINTENANCE PRACTICES

1. Removal/Installation Exhaust Gas Temperature Thermocouple

A. Remove Exhaust Gas Temperature Thermocouple (See figure 201.)

(1) Obtain access to thermocouples by opening side cowl panels.

(2) Remove thermocouple harness leads from thermocouples.

(3) Remove two bolts which fasten thermocouple to exhaust chamber.

(4) Remove thermocouple from engine.

B. Install Exhaust Gas Temperature Thermocouple (See figure 201.)

(1) Place thermocouple on mounting pad so that four gas holes in sampling probe face upstream.

(2) Install and tighten two mounting bolts 40 to 50 pound-inches.

(3) Connect thermocouple harness leads to studs on thermocouples and torque nuts to approximately 20 pound-inches.

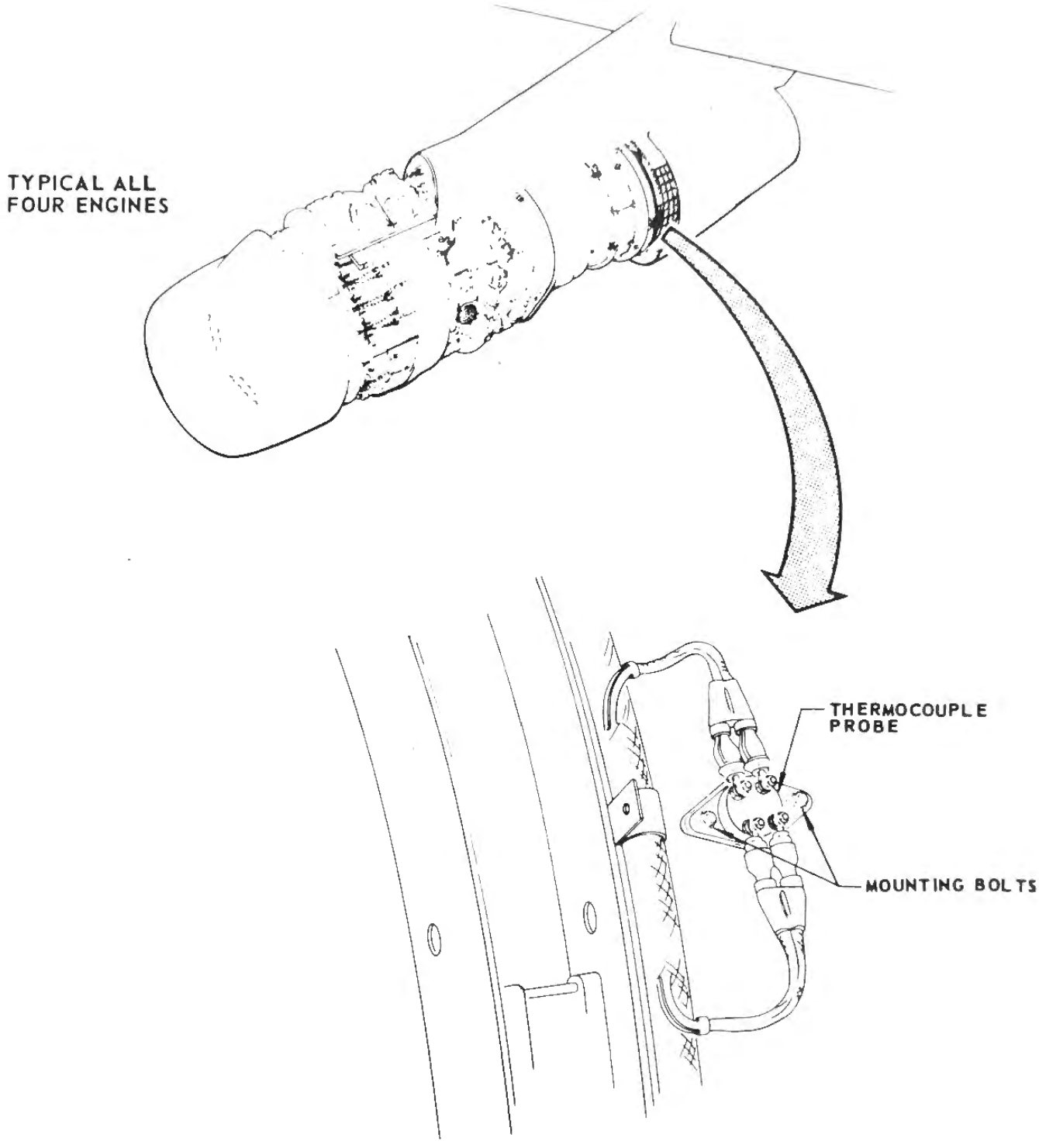
(4) Close side cowl panels.

2. Adjustment/Test Exhaust Gas Temperature Thermocouple

A. Test Exhaust Gas Temperature Thermocouple

(1) Place a soldering iron of at least 500 watts capacity against a thermocouple probe. Observe exhaust gas temperature indicator on engine instrument panel which should show a small reading. Allow time for indicator to return to zero then repeat procedure for each thermocouple probe.

NOTE: This is not a calibration check.



Exhaust Gas Temperature Thermocouple Installation
Figure 201

EXHAUST GAS TEMPERATURE THERMOCOUPLE HARNESS AND LEAD - MAINTENANCE PRACTICES

1. Removal/Installation Exhaust Gas Temperature Thermocouple Harness and Lead

A. Remove Thermocouple Harness and Lead

(1) Disconnect thermocouple averaging circuit connector forward of engine fireseal.

(a) On engines fitted with Bendix connector, disconnect plug. (See figure 201, view 1.)

(b) On engines fitted with terminal type connector, remove teflon tape, and disconnect terminals. (See figure 201, view 2.)

(2) Remove locknuts and bolts securing averaging circuit connector receptacle mounting bracket or terminal support fitting to engine fireseal.

(3) On engines fitted with Bendix connector, remove receptacle from mounting bracket.

(4) Pulling aft on averaging circuit lead, remove receptacle or terminal support fitting from engine fireseal.

(5) Remove locknuts and bolts securing test receptacle mounting bracket to engine fireseal.

(6) Remove test receptacle from mounting bracket.

(7) Pulling aft on test circuit lead, remove receptacle from engine fireseal.

(8) Disconnect thermocouple leads from probe terminals.

(9) Remove nuts and screws securing thermocouple harness and lead supporting clips.

NOTE: Tag harness and lead supporting clips being removed to assure their reinstallation in same location.

(10) Remove harness and leads

CAUTION: IN ALL HANDLING AND STORAGE, THE HARNESS AND LEADS SHOULD BE HUNG ON A RACK OR LAID ON A CLEAN TABLE FREE OF OIL AND MATERIAL WITH WHICH IT MAY BECOME ENTANGLED. SEVERE REPEATED FLEXING AND BENDING OR TWISTING WILL BREAK OR FRAY THE EXPOSED INSULATION. IF HUNG ON A RACK, CARE MUST BE TAKEN NOT TO INTRODUCE ANY SMALL RADIUS BENDS IN ANY PART OF THE ASSEMBLY.

NOTE: On earlier turbofan engines, there is additional harness and lead connectors, located above thrust reverser actuators. To remove this type of harness, remove test circuit lead connector from support bracket, but do not disconnect averaging circuit lead terminals. (See figure 201, view 3).

(11) Remove nuts and screws securing averaging circuit lead (from engine fireseal to strut firewall) supporting clips.

(12) Disconnect averaging circuit lead connector at strut firewall (See figure 201, detail A), and remove lead.

B. Install Thermocouple Harness and Lead

(1) Position averaging circuit lead (from engine fireseal to strut firewall) on engine, and install supporting clips using screws and nuts.

(3) Position harness and leads on engine, and install supporting clips using screws and nuts.

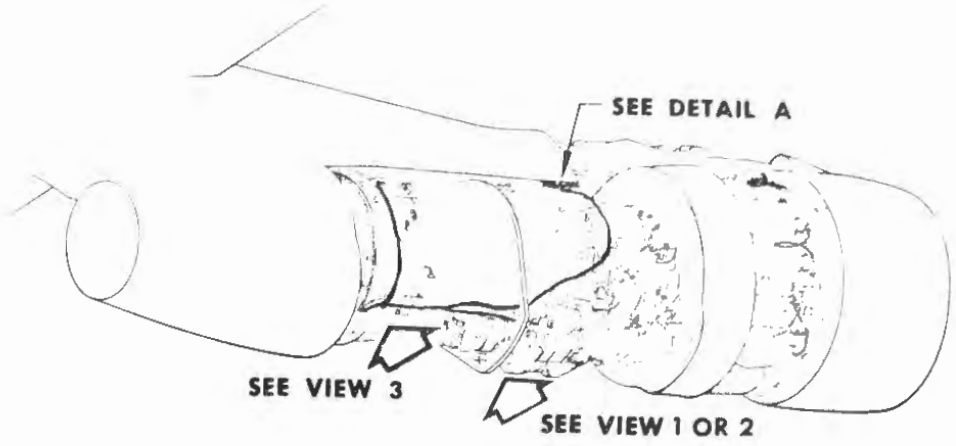
NOTE: On earlier turbofan engines with additional thermocouple lead connectors, located above thrust reverser actuators, install test circuit lead connector to its support bracket. (See view 3.)

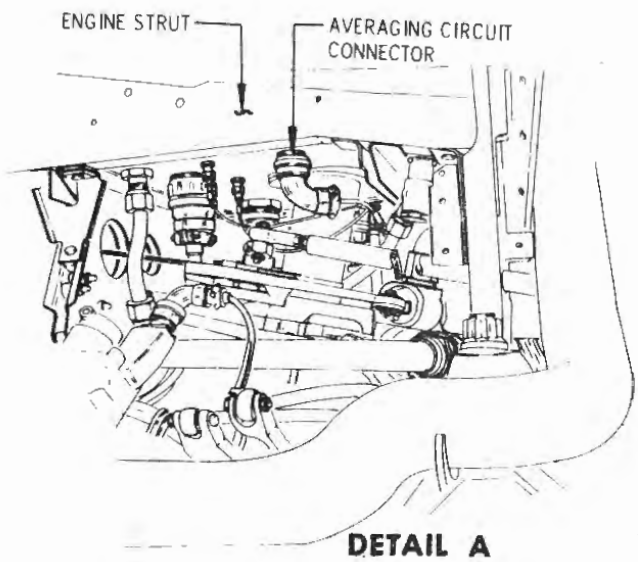
(4) Connect thermocouple leads to probe terminals.

(5) Pull test receptacle forward through engine fireseal. (See figure 201, view 1 or 2.)

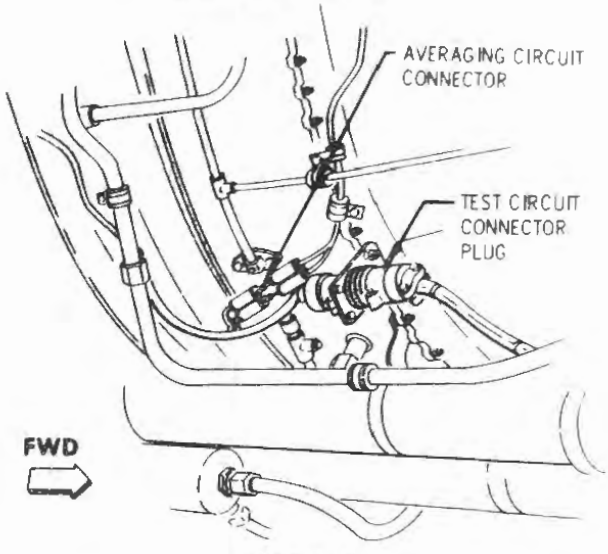
(6) Secure test receptacle to mounting bracket.

(7) Secure test receptacle mounting bracket to engine fireseal using bolts and locknuts.

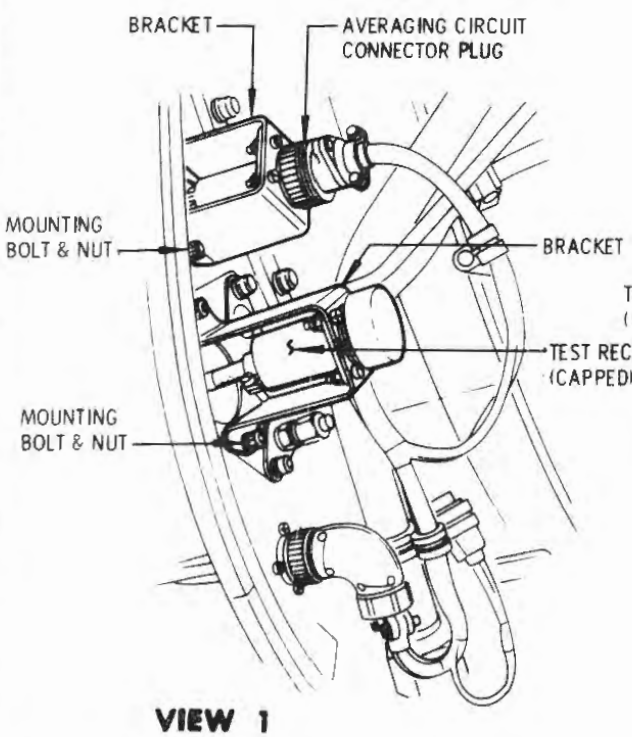




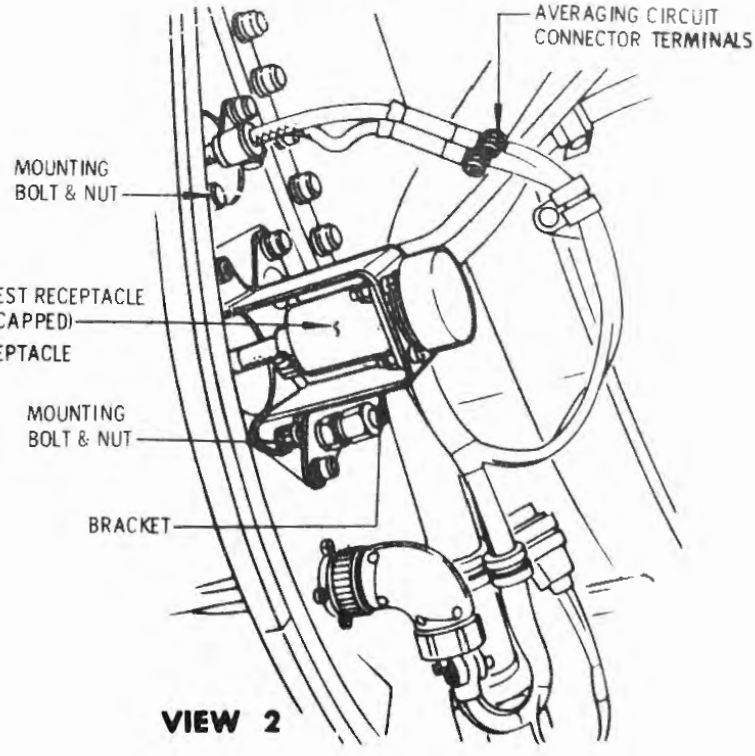
DETAIL A



VIEW 3



VIEW 1



VIEW 2

Exhaust Gas Temperature Thermocouple Harness and Lead Installation
Figure 201

(8) Pull averaging circuit connector receptacle or terminal support fitting forward through engine fireseal. (See figure 201, view 1 or 2).

(9) On engines fitted with Bendix connector, install receptacle to mounting bracket.

(10) Secure averaging circuit connector receptacle mounting bracket or terminal support fitting to engine fireseal using bolts and locknuts.

(11) Connect averaging circuit connector.

(a) On engines fitted with Bendix connector, connect plug.

(b) On engines fitted with terminal type connector, connect terminals and wrap connection with teflon tape.

CAUTION: BE SURE THERE IS ENOUGH INSULATING MATERIAL BETWEEN THE TWO SETS OF CONNECTED TERMINALS TO PREVENT SHORTING OUT THE SYSTEM.

2. Adjustment/Test Exhaust Gas Temperature Thermocouple Harness and Lead

A. Equipment and Materials

(1) Sensitive resistance measuring device - ohmmeter with a center scale value of approximately 10 ohms.

(2) Low voltage ohmmeter capable of measuring resistance of 50,000 ohms. Meter should utilize less than 40 volts (dc) and should have an accuracy of five percent.

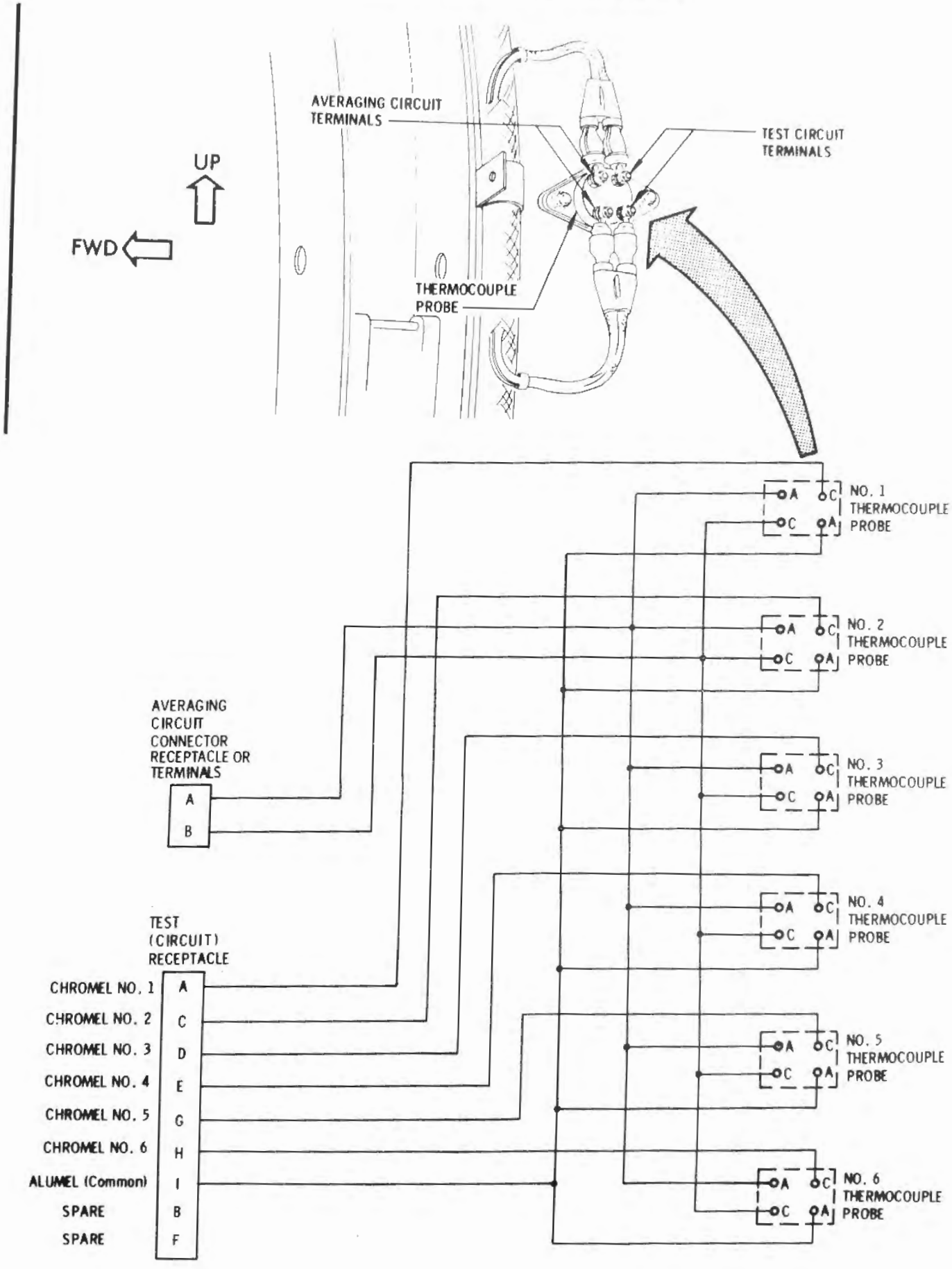
B. Test Thermocouple Harness and Lead Resistance

(1) Open both cowl panels on engine.

(2) Disconnect thermocouple averaging circuit connector forward of engine fireseal.

(a) On engines fitted with Bendix connector, disconnect plug. (See figure 201, view 1.)

(b) On engines fitted with terminal type connector, remove teflon tape and disconnect terminals. (See figure 201, view 2.)



Thermocouple Harness and Lead Wiring Diagram
Figure 202

(3) Place ohmmeter (sensitive) terminals in contact with averaging circuit fireseal connector pins "A" and "B" or alumel and chromel terminals (See figure 202), and measure resistance. Maximum allowable resistance is 2.05 ohms at 68°F (20°C).

(4) Remove protective cap from test receptacle.

(5) Place one ohmmeter terminal in contact with test receptacle pin "I," other terminal in contact with pin "A," and measure resistance. Maximum allowable resistance is 2.50 ohms at 68°F (20°C).

(6) Repeat step (2) always leaving one ohmmeter terminal on pin "I," or common pin, and placing other terminal in contact with each chromel pin successively ("C," "D," "E," "G," "H").

(7) If resistance is not within limits, disconnect both sets of leads from thermocouple probes and measure resistance of each thermocouple. (Resistance across thermocouple alumel and chromel terminals). Resistance of each thermocouple shall not exceed 0.250 ohms.

(8) If resistance of each thermocouple is within limits, harness is faulty and should be replaced.

C. Test Thermocouple Harness and Lead Continuity

(1) Install jumper across averaging circuit connector pins "A" and "B" or alumel and chromel terminals.

(2) Disconnect both averaging circuit leads from thermocouple probe terminal studs on each probe if not already disconnected. Refer to figure 201.

(3) Place or clamp ohmmeter (sensitive) terminals in contact with one set of disconnected thermocouple probe lead terminals. Refer to figure 202.

(4) Flex harness and leads gently and observe instrument needle. If continuity does not exist, replace harness and leads.

NOTE: Broken wires which come in contact intermittently due to flexing will cause needle to fluctuate. False intermittent indications will result if ohmmeter terminals are not in firm contact with clean terminals, or if ohmmeter terminals or leads are defective.

(5) Repeat steps (3) and (4) for other thermocouple probes.

(6) Remove jumper from pins "A" and "B" or alumel and chromel terminals.

(7) Place one ohmmeter terminal in contact with test receptacle pin "I" and other ohmmeter terminal in contact with test receptacle pin "A."

(8) Flex harness and leads gently and observe instrument needle. If continuity does not exist, replace harness and leads. Refer to note in step (4).

(9) Repeat steps (7) and (8) always leaving one ohmmeter terminal in contact with pin "I," or common pin, and placing other ohmmeter terminal in contact with each chromel pin successively ("C," "D," "E," "G," "H").

D. Test Thermocouple Harness and Lead Insulation Resistance.

WARNING: TO REDUCE POSSIBILITY OF IGNITING FUEL, DO NOT USE A MEGGER OR OTHER HIGH VOLTAGE OHMMETER.

(1) Check averaging circuit insulation resistance between conductors by placing one ohmmeter (low voltage, high resistance) terminal in contact with connector pin "A" or alumel terminal, and other ohmmeter terminal in contact with pin "B" or chromel terminal, and measure resistance. Resistance shall not be less than 50,000 ohms.

(2) Check averaging circuit insulation resistance between conductor and ground by placing one ohmmeter terminal in contact with connector receptacle pin "A" or alumel terminal and other ohmmeter terminal in contact with stainless steel wire braid and measure resistance. Resistance shall not be less than 50,000 ohms.

(3) Repeat step (2) using averaging circuit receptacle pin "B" or chromel terminal.

(4) Disconnect both test circuit leads from thermocouple probe studs on each probe. Refer to figure 202.

(5) Check test circuit insulation resistance between conductors by placing one ohmmeter terminal in contact with receptacle pin "I" and other ohmmeter terminal in contact with each chromel pin successively and measure resistance. Resistance shall not be less than 50,000 ohms.

(6) Check test circuit insulation resistance between conductor and ground by placing one ohmmeter terminal in contact with receptacle pin "I" and other ohmmeter terminal in contact with stainless steel wire braid and measure resistance. Resistance shall not be less than 50,000 ohms.

(7) Repeat step (6) using every chromel pin in place of alumel pin "I."

(8) If resistance in any previous step was measured less than 50,000 ohms, proceed as follows: If full-scale deflection (zero ohms) was recorded, reject parts; if large (but not full-scale) deflection was recorded, presence of carbon or excessive moisture was indicated. Carbon yields a fairly steady reading. Moisture tends to produce readings which waver or drift after 5 to 30 seconds.

(9) If presence of moisture was indicated, remove harness and leads and bake at 200° to 250°F (93° to 121°C) for one hour and recheck resistance. A substantial increase in readings indicates that moisture was cause of original low values.

(10) Install harness and leads.

(11) Connect leads to thermocouple probe studs.

(12) Replace protective cap on test receptacle.

(13) Connect averaging circuit connector forward of engine fireseal.

(a) On engines fitted with Bendix connector, connect plug.

(b) On engines fitted with terminal type connector, connect terminals and wrap connection with teflon tape.

CAUTION: BE SURE THERE IS ENOUGH INSULATING MATERIAL BETWEEN THE TWO SETS OF CONNECTED TERMINALS TO PREVENT SHORTING OUT THE SYSTEM.

(14) Close engine cowl panels.

ENGINE TACHOMETER SYSTEM - DESCRIPTION AND OPERATION

1. General

A. The engine tachometer system (figure 1) allows the rotary speed of an engine low pressure or high pressure compressor rotor to be read on indicators located in the control cabin. Each engine compressor drives a generator which supplies a three-phase electrical signal to operate the appropriate indicator.

B. The engine tachometer system has two generator units (N_1 and N_2) on each engine and corresponding tachometer indicators on the pilot's engine instrument panel. Tachometer system N_1 indicates the speed of rotation of the low pressure compressor. Tachometer system N_2 registers the speed of rotation of the high pressure compressor.

2. Engine Tachometer Generator

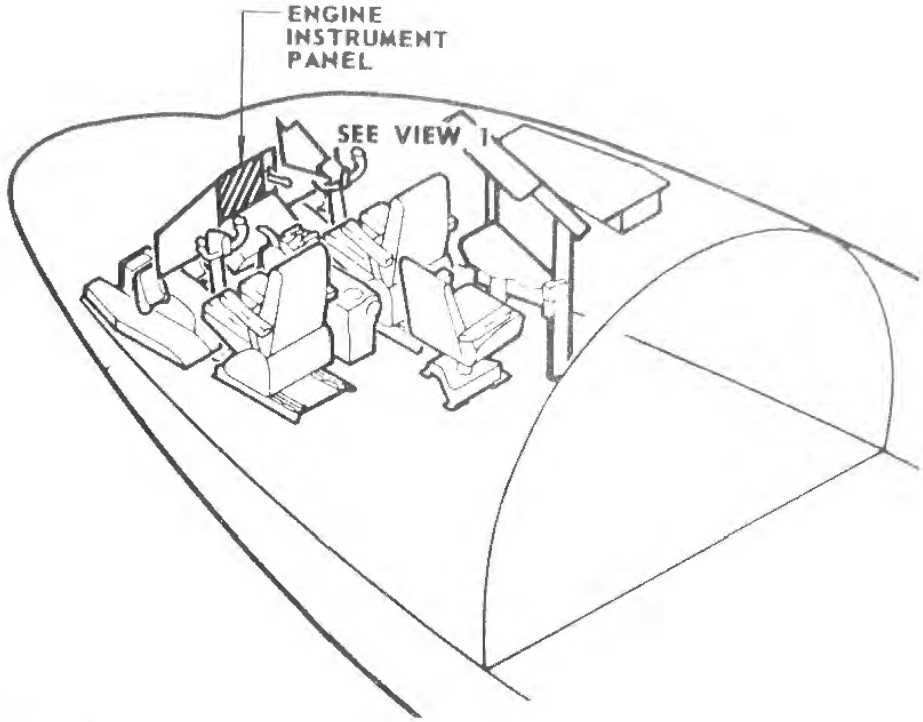
A. The engine tachometer generators (N_1 and N_2) supply a-c power for the operation of the indicators. Each tachometer generator consists of a stator and a permanent magnet rotor. The generator drive shaft turns the rotor inside the stator coils which produce an electrical signal whose frequency is a function of the engine compressor rpm. This signal is transmitted to the corresponding tachometer indicator by a two-wire system; the third phase is completed by ground. (See figure 2.)

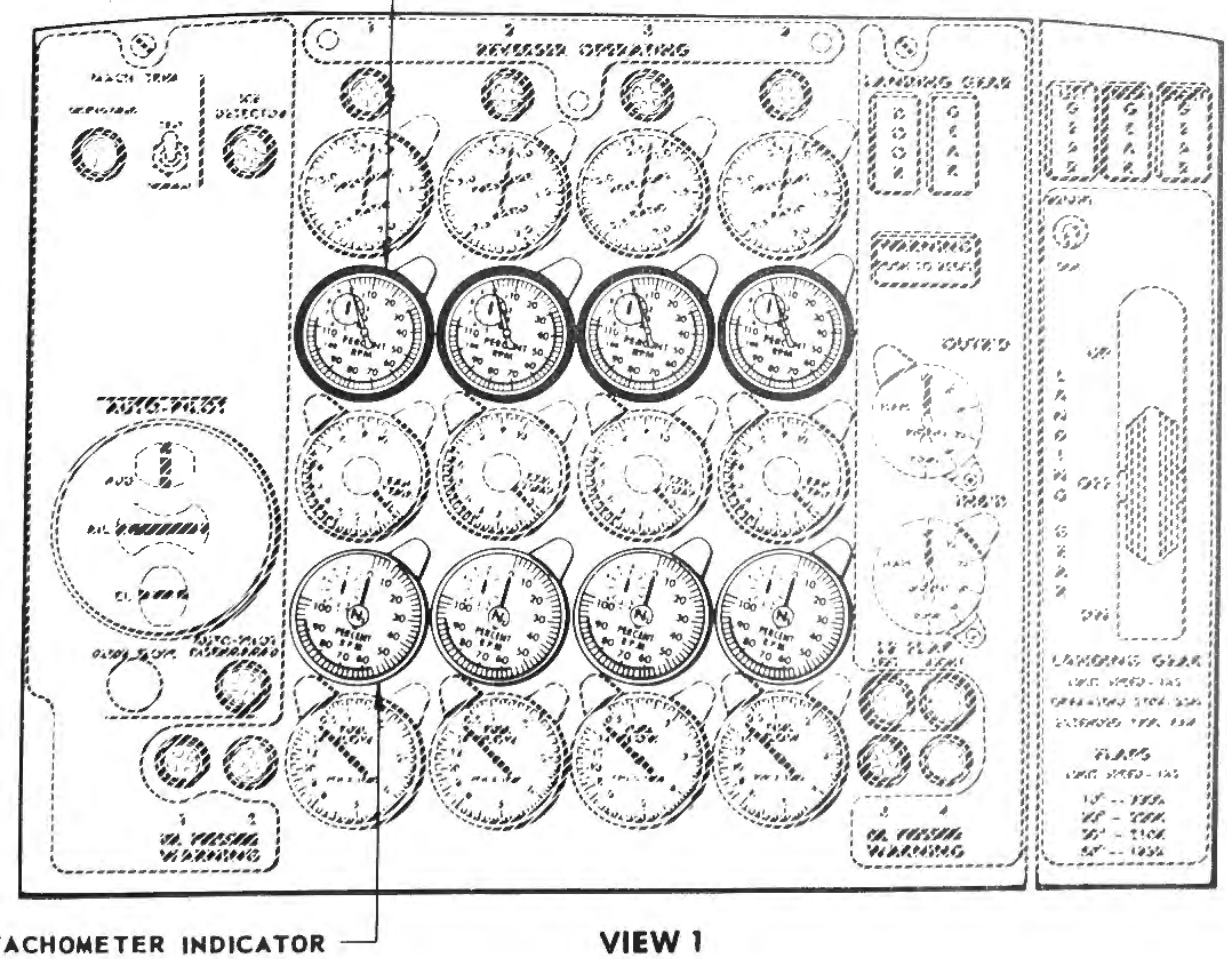
B. The N_1 tachometer generator (detail A, figure 1) is located on the front accessory drive and the N_2 tachometer generator (view 2, figure 1) is located on the aft right side of the main accessory drive gear box. Each generator is driven by its respective compressor rotor through reduction gearing.

3. Generator Tachometer Indicator

A. Each engine tachometer indicator shows its respective engine rotor speed as a percentage of permissable maximum engine speed.

B. Each tachometer indicator is hermetically sealed and mounted on the engine instrument panel. (See figure 1.) It contains a three-phase synchro-motor driving an induction drag cup mechanism. The synchro motor rotates at the same speed as the tachometer generator. The indicator dial is calibrated for reading between zero and 110% rpm.

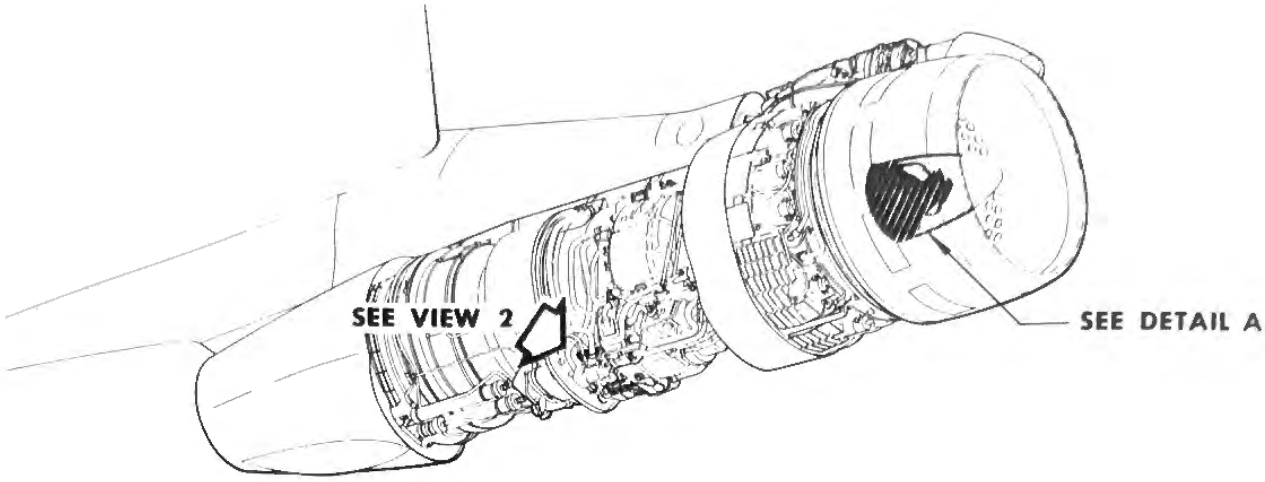




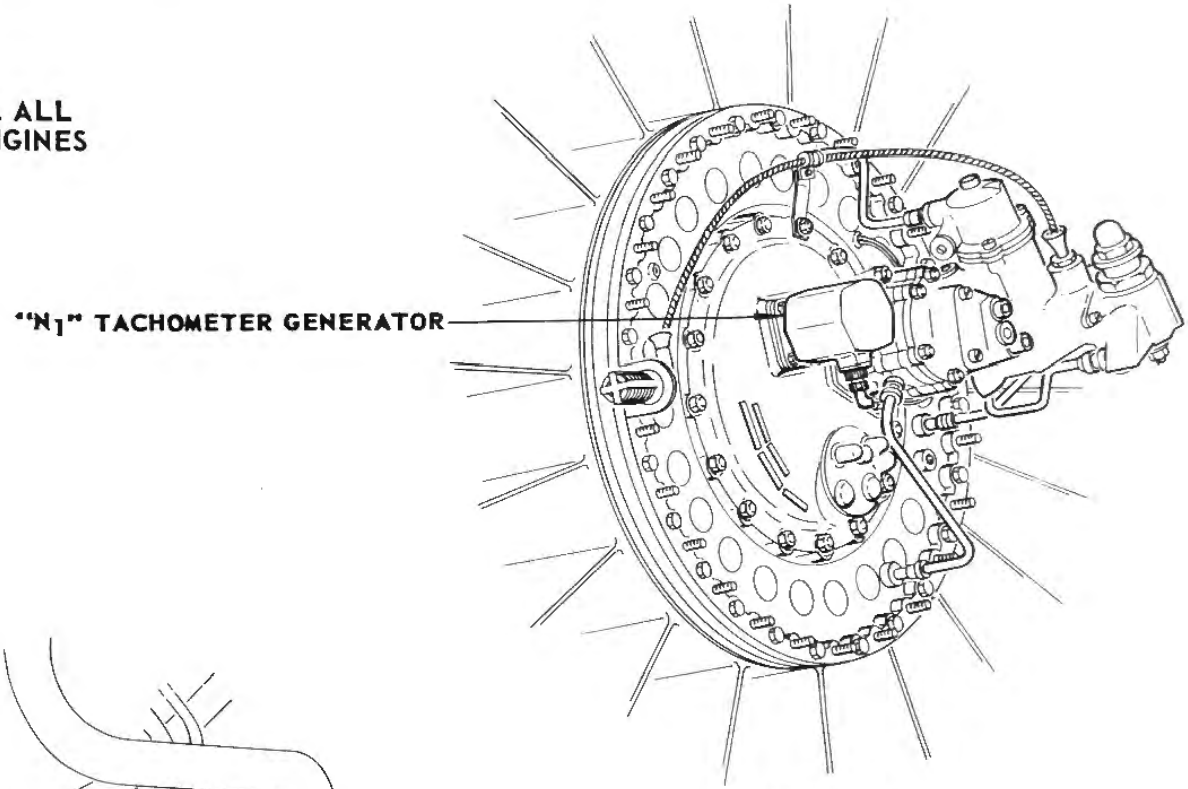
VIEW 1

Engine Tachometer System Equipment Location
Figure 1 (Sheet 1 of 2)

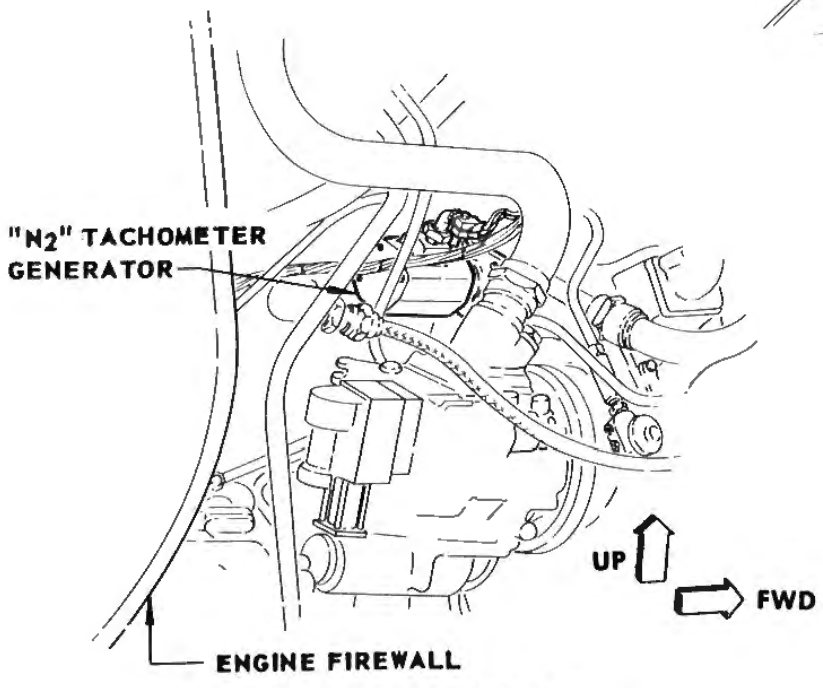
(2)
May 15/61
Revised



TYPICAL ALL
FOUR ENGINES

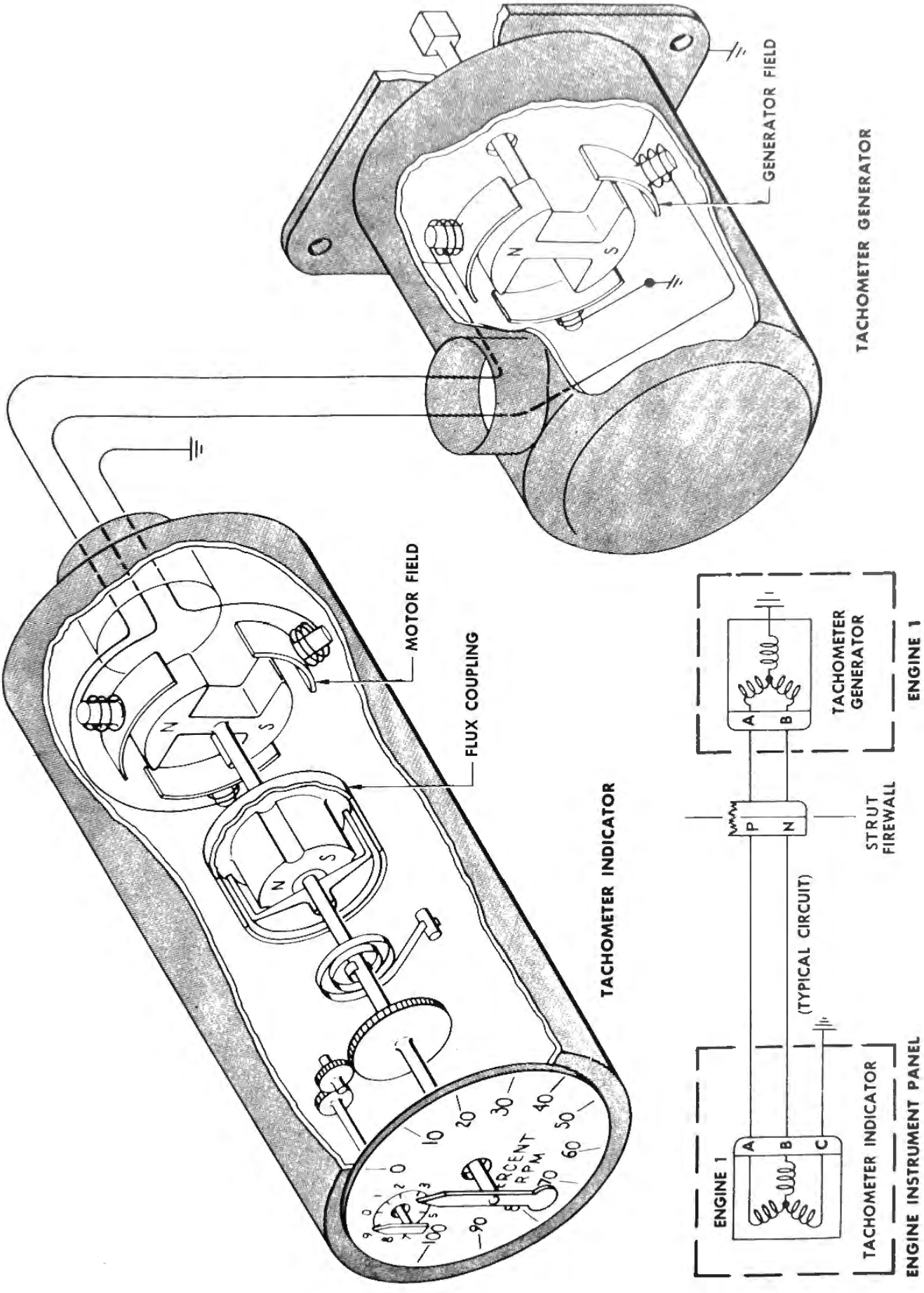


DETAIL A



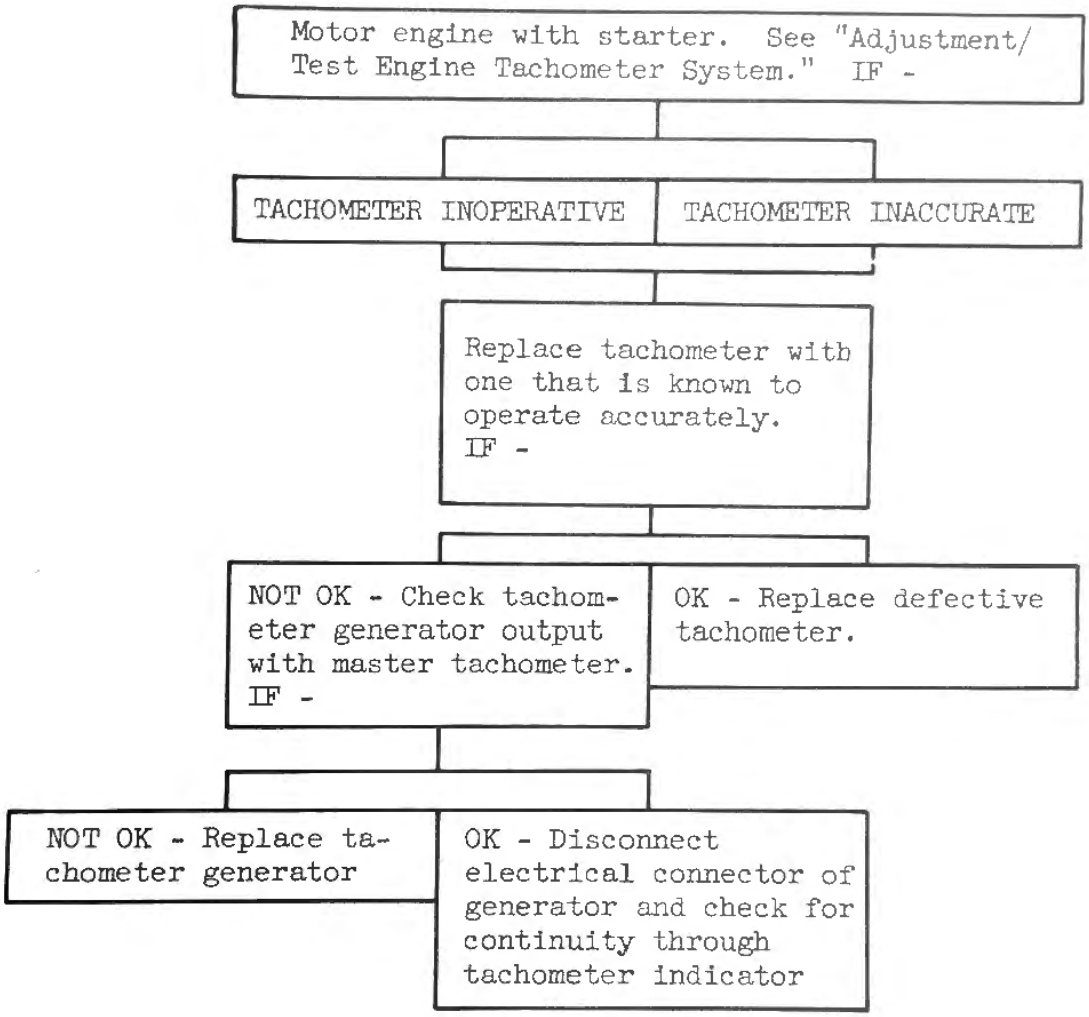
VIEW 2

Engine Tachometer System Equipment Location
Figure 1 (Sheet 2 of 2)



Engine Tachometer Schematic
Figure 2

ENGINE TACHOMETER SYSTEM - TROUBLE SHOOTING



ENGINE TACHOMETER SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Engine Tachometer System

   A. General

      (1) The engine tachometer system can be tested only during engine run-up.

   B. Equipment and Materials

      (1) Master Tachometer (with calibration correction chart)

      (2) Adapter harness for master tachometer.

   C. Test Engine Tachometer System

      (1) Remove tachometer indicator from instrument panel.

      (2) Using adapter harness, connect master tachometer into system in parallel with engine tachometer indicator.

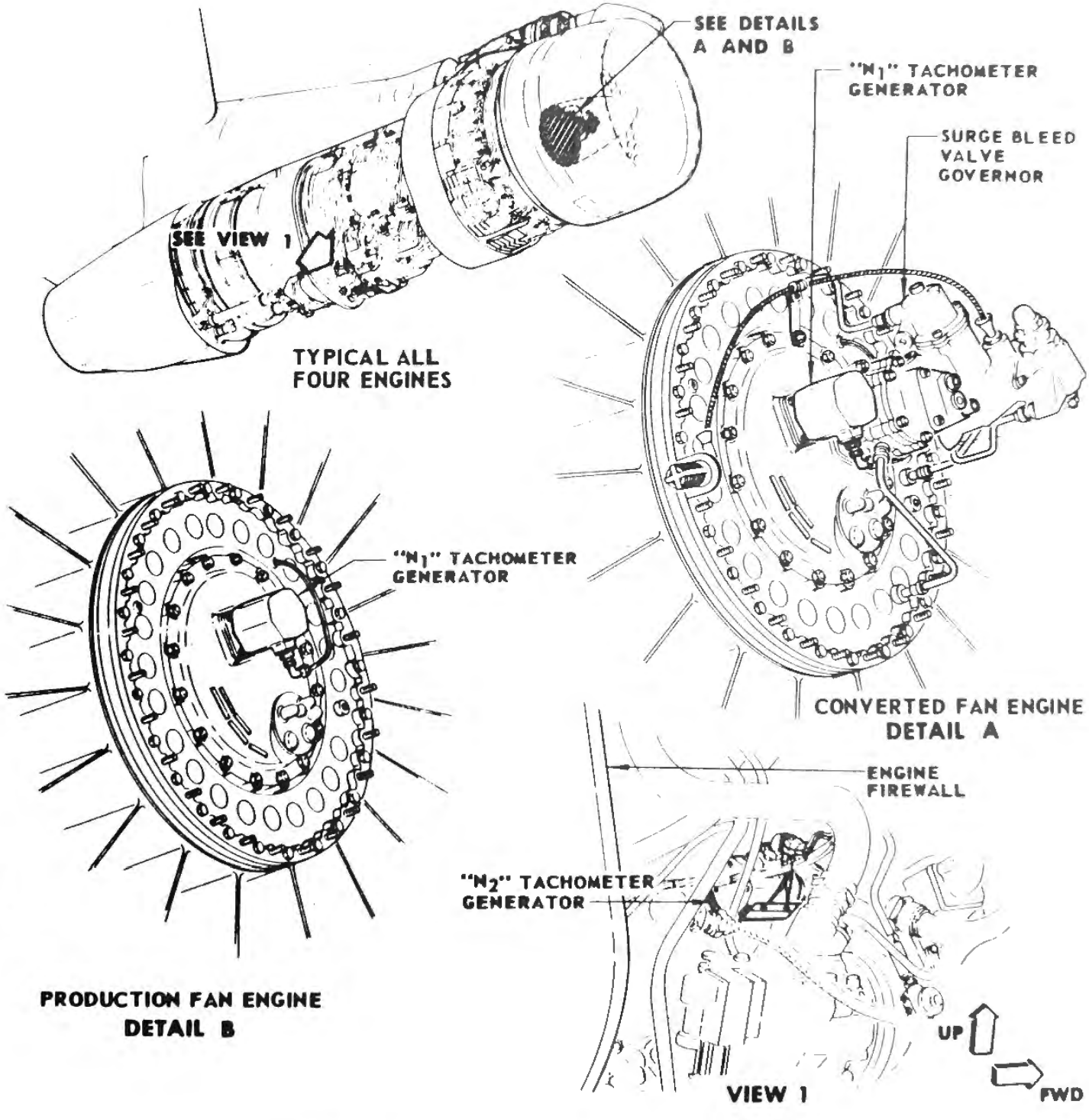
         NOTE: Compare reading of the engine tachometer indicator with that of the master instrument at all speeds. At speeds below 95% rpm both instruments must agree within 2% rpm. At engine rpm between 95 and 102% both instruments must agree within 1%.

ENGINE TACHOMETER GENERATOR - MAINTENANCE PRACTICES

1. Removal/Installation Engine Tachometer Generator

A. Equipment and Materials

(1) Grease - MIL-L-3545, or equivalent



Engine Tachometer Generator Installation
Figure 201

B. Remove Engine Tachometer Generator (See figure 201.)

(1) Disconnect electrical connector from applicable engine tachometer generator.

(2) On N_2 tachometer generator, remove insulation type heat shield (if fitted).

(3) Remove attaching nuts and washers which fasten tachometer generator to drive.

(4) Remove generator and discard old gasket.

NOTE: Removal of N_2 generator is made easier if ignition harness is disconnected from ignitor and moved to one side. Refer to Chapter 74.

CAUTION: CHECK CONDITION OF N_2 TACHOMETER GENERATOR HEAT SHIELD (IF FITTED) BEFORE INSTALLATION. IF TORN OR DAMAGED DISCARD AND REPLACE WITH NEW ONE.

C. Install Engine Tachometer Generator (See figure 201.)

(1) Lightly coat splines of tachometer generator drive shaft with grease.

(2) Place new gasket on mounting pad.

(3) Place engine tachometer generator on mounting pad and carefully align drive shaft of tachometer generator.

(4) Install washers and nuts attaching generator to engine.

(5) Install insulation type heat shield (if fitted) around sides nearest to engine of N_2 tachometer generator.

(6) Attach electrical connector to generator.

ENGINE VIBRATION INDICATING SYSTEM WIRING PROVISION - DESCRIPTION AND OPERATION

EFFECTIVITY

AIRPLANE VH-EBH THROUGH VH-EBJ

1. General

A. Wiring provision is made between each engine nacelle strut and the control cabin to allow installation of engine vibration indicating equipment. This wiring is provided with capped disconnect plugs at the flight engineer's panel and at the electronic equipment rack in the lower nose compartment.